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ABSTRACT

Reported is a formative evaluation of the Biological Science Curriculum Study "Biological Science: Patterns and Processes", designed for academically unsuccessful students. "Criterion referenced" tests were developed, with items selected to indicate the extent of students' learning rather than to discriminate between students. An alternate form, pretest-posttest research design was used. Randomly selected students within classes of teachers who had participated in feedback and training activities were given alternate test forms for each of five content areas. Scores on these tests served as the dependent variables with scores on Verbal Reasoning and Numerical Ability subtests of the Differential Aptitude Test, and Davis Reading Test scores serving as independent variables. Data were also collected on school and community characteristics. Analysis of covariance and multiple regression analysis showed significant differences between classes (tentatively attributed to teacher performance), and significant correlations between reading comprehension and achievement. Recommendations are made for revision of the materials and for similar evaluative studies. Appended are tables of results and statistical analyses, and copies of tests used. (EB)

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FINAL REPORT

Project No. 9-H-012

Grant No. OEG-8-9-150012-2018(058)

A FORMATIVE EVALUATION OF
BIOLOGICAL SCIENCE: PATTERNS AND PROCESSES

William V. Mayer, Project Director
Richard C. Anderson, Consultant
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BSCS S/M EVALUATION

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Chapter 1

Background of the Study

There is a large group of students in American schools that, for a variety of reasons, may be categorized as academically unsuccessful. Until recently, no concerted effort has been made to delineate the characteristics of this group and to prepare curricular materials that provide academic successes while maintaining integrity of the content and developing its relevance for the student. In 1966, the Biological Sciences Curriculum Study commercially released a program in biological sciences for the academically unsuccessful entitled Biological Science: Patterns and Processes.

Based on feedback comments from teachers and students, the materials have been remarkably successful. However, no quantitative data exist to justify the claims of success for these materials and for the unique instructional procedures they entail. If this program is to serve as a model for curriculum development in other disciplines, critical and objective evaluations of the attainments of students taught with materials of this type are needed.

The BSCS originally developed three parallel sets of course materials for high school biology: Biological Science: Molecules to Man (Blue Version), High School Biology: BSCS Green Version, and Biological Science: An Inquiry Into Life (Yellow Version). These materials were prepared by teams of writers working at Summer Writing Conferences during three successive years--1960, 1961, and 1962. In the years following each of the first two summers' work, the materials were widely tested and reviewed to give feedback for rewriting.

The BSCS became interested in pupils exhibiting poor achievement during the years the three BSCS Versions were being evaluated (1960-63). A Special Materials Committee was organized in 1962 to determine the characteristics of these students and to make recommendations as to how they might best be taught. The Committee examined and analyzed the literature on deprived youngsters, school dropouts, and students with learning problems. They interviewed teachers of the academically unsuccessful student and observed them with their classes. Data collected during the evaluation of the Versions were examined for criteria that could be used to predict student success.

After an exhaustive study of all these data and materials, the Committee prepared a plan for the development of materials in biology that could be expected to be more suitable for these academically unsuccessful students. The plan included:

(a) writing the materials at a reading level in keeping with the students' abilities, while keeping formal reading assignments at a minimum--to produce essentially an "unbook."

(b) providing interesting activities within a framework of multisensory perceptions in the classroom situation.

(c) constructing materials so that they would lead, in small steps, from one fact to another, eventually to a generalization and then to a new concept.

(d) centering the learning situations around laboratory activities as much as possible in order to capitalize upon the potential interests and abilities of these students.

(e) structuring the development of selected concepts common to all three of the BSCS Versions, but in a manner especially suitable to the characteristics of these students.

(f) developing activities and procedures that served to demonstrate the role of inquiry in the accumulations of knowledge upon which the theories of modern biology are based.

With these guidelines, BSCS writing teams, composed of high school teachers, college biologists, educational psychologists and science educators, proceeded to develop experimental materials that were used and evaluated in classroom situations by a total of 300 teachers and 15,000 students. Several revisions were made prior to commercial publication. Teachers involved in the 1964-65 evaluation of these materials provided feedback used in the summer of 1965 to guide the final revision which is published commercially by Holt, Rinehart and Winston, Inc., under the title Biological Science: Patterns and Processes.

Curriculum development projects typically rely upon very indirect data to evaluate instructional materials and teaching procedures. The prime data are the opinions of teachers. Usually the teacher is asked to evaluate rather large units of material and whole systems of concepts with a brief comment and a rating or two. It is not clear what criteria and what standards of excellence are being applied when a teacher judges a lesson to be successful or unsuccessful. Student interest may not be clearly delineated from student learning. The impressions of a teacher, as a participant-observer, may be unduly colored by the performance of a few students. Finally, even when there is consensus that a lesson was unsuccessful, teacher evaluations will not always be helpful in identifying the gaps in student understanding that must be filled to make the lesson a success. To be sure, teacher judgments do provide important information, but they cannot reasonably bear the whole burden of identifying the strengths and weaknesses of an instructional program, especially if there are attractive alternates. One such alternative is the substance of this study.

Of the several things that should be taken into consideration when curricula are evaluated, student learning is among the most important. It seems obvious that a direct measure of student performance will be a better indicator of learning than teacher impressions. Indeed, there is evidence that designing lessons on the basis of student performance data can result in substantially improved instruction.[1]

The BSCS, because of its participation in the effort to design instructional materials for this special purpose and population, is in a uniquely advantageous position to test the result, and, hopefully, to suggest to educators as a whole the criteria upon which success or failure in this effort may rest.

This study, therefore, was directed toward the application of more effective evaluative techniques to assist in improving instruction for a significant fraction of the school population that has been consistently neglected. A major purpose of this study was to obtain reliable data on the effectiveness of the current materials in order to determine which procedures most improve the impact of these materials on problems of teaching the academically unsuccessful student significant ideas of modern biology. Subsidiary goals are to demonstrate the effectiveness of the overall design of these materials and to develop tests that could eventually be used by teachers for classroom evaluation of the academically unsuccessful student. Successful completion of this project may well provide a precedent and example which can be followed by other projects and for other materials to advance the cause of improved instruction for all students of the sciences.

One reason for giving achievement tests is to evaluate students; that is, to rank them, to assign grades, or predict those likely to do well in college. When this is the purpose, it is appropriate to use the classical psychometric model. According to this model the likelihood of reliable discriminations between students is maximized when (1) the correlation of each item score with the total test score is maximized, and (2) the difficulty level of the items is as close to 50 percent as possible. When the full-dress treatment is given to the development of an achievement test, a large pool of items is tried out with a sample from the population for which the test is intended. Items that perform best in terms of the two criteria listed above are included in the final version of the test.

A second reason for giving achievement tests is to evaluate the quality of instruction. Two somewhat different purposes may be distinguished. The first is "summative evaluation", so called because the purpose is to give a final test to a total instructional package, perhaps comparing it to competing programs, in order to provide potential consumers with information upon which to make a use decision. The second is "formative evaluation", wherein the purpose is to provide information to authors or teachers to help them improve the instructional program. Of these two goals, this study was concerned primarily with formative evaluation.

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[1] C. Anderson, "Educational Psychology." Annual Review of Psychology 18 (1967): 129-164.

It is only in the last few years that it has become clear to educational researchers that the classical psychometric model is inappropriate for either summative or formative evaluation.[2,3,4] The procedures for selecting items dictated by the model cause the evaluator to discard items that most students answer correctly. Consequently, information about which concepts were well learned is lost. More serious, however, is the fact that items on which everyone does poorly are eliminated and, therefore, information about the weak points in the instructional program is systematically destroyed. The better the instruction that precedes the test the more likely the test is to contain tricky, hairsplitting questions on the footnotes rather than the main themes of instruction. This state of affairs follows from the logic of the model implying that the difficulty level of a test should be 50 percent no matter how much and how well students have learned. Finally, the criterion that individual items should correlate highly with the total score biases the selection of items in the direction of those which measure relatively enduring student raits like verbal ability. At the same time, this criterion probably involves a bias against selecting items that are sensitive to immediate situational factors; for instance, whether the student has been subject to good or poor teaching.

The objections to the classical psychometric model have been detailed here because the major course content improvement projects, including the Biological Sciences Curriculum Study, have uniformly developed achievement tests that are psychometrically "good."

This study attempted to employ "criterion-referenced" tests. The sole basis for selecting a test item was whether the student's answers to the item would indicate the extent to which he understood an important concept (or could apply a problem-solving skill, use an experimental technique, etc.). There was no attempt to regulate the difficulty of items in advance of the research. The whole point of the research was to determine easy items (student learned and he now understands) and difficult items (the student did not learn and he did not understand).

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[2] R.Glaser, "Instructional Technology and the Measurement of Learning Outcomes: Some Questions, "American Psychologist 18 (1963): 519-521.

[3] Richard C. Cox and Julie S. Vargas, A Comparison of Item Selecting Techniques for Norm-referenced and Criterion-referenced Tests, (Pittsburgh, Pennsylvania: Learning Research and Development Center, University of Pittsburgh, February, 1966).

[4] Ralph W. Tyler, Robert M. Gagne, and Michael Scriven, Perspectives of Curriculum Evaluation, American Educational Research Assn. Monograph Series, (Washington, D.C.: Rand McNally & Co., 1967).

Chapter 2

Research Design and Analysis

Research Design

The course materials, Biological Science: Patterns and Processes, were divided into five areas of study: ecological relationships, cell energy processes, reproduction and development, genetic continuity, and organic evolution. Each area of study was analyzed for significant concepts that served as guides for developing test items.[1] Items were sorted into two test forms, A and B, of equal length, with at least one item for each concept. In this way alternate forms for each of five unit tests were developed. Randomly selected students within each class were administered these alternate forms for each unit test as shown in Figure 1.

Classroom Subgroups	Pretest Form	Instruction	Posttest Form
Subgroup 1	A	X	B
Subgroup 2	B	X	A

Figure 1. The Alternate Form, Pretest-Posttest Design

This alternate form, pretest-posttest design, eliminated the facilitation of posttest performance of a single form design and had the additional advantage that data on twice as many items were obtained with the same investment of student time. The number of items per student is an important consideration when the purpose is to discriminate among students, but when the goal is to discriminate between the well-learned and not well-learned concepts, the number of items becomes paramount.

A control group was not required in that the purpose of the study was to identify the effects of instruction with particular materials so that the revision of materials and suggestions for teacher adaptation of materials could be accomplished.

The five pairs of alternate form multiple-choice tests served as the dependent variables in the study. The Verbal Reasoning (VR) and Numerical Ability (NA) sub-tests of the Differential Aptitude Test (DAT), Form A, and the Davis Reading Test (DRT), Comprehension, and Speed Tests served as independent variables. In addition to the test data on the student population, community characteristics and school district size were secured through a teacher questionnaire and from published statistical data.

1.See Chapter 4-7.

2.Gerald Kahn and Warren Hughes, "Statistics of Local Public School Systems, 1967. Fall 1967: Pupils Schools/Staff. 1966-67: Expenditures." National Center for Educational Statistics, Government Printing Office, Washington, D.C.: Superintendent of Documents, March, 1969.

Analysis

The data were subjected to statistical analysis on the CDC 6400 computer at the University of Colorado, Boulder.

The initial analysis was run early in June to provide data for the writing team to use in improving the Revised Edition of Patterns and Processes. Output from the initial run included the percent correct on the pretest and posttest, and the percent possible gain[3] for the groups of items comprising each of the concepts on each test administered.

Later, a complete item analysis was run on each test using the FORTAP (Fortran Test Analysis Package) program developed by Baker and Martin[4] and modified by personnel of the Laboratory of Educational Research, Univeristy of Colorado, Boulder. Data obtained with this program included mean, standard deviation, standard error, and a Hoyt Reliability estimate for each test. In addition, difficulty (% correct), R biserial, X 50-values and β-values were printed out for every response on every test item.

The results of the initial FORTAP analysis were carefully scrutinized, and some items were eliminated on the basis of logical, factual, or structual errors in the item itself. Before any subsequent analysis was conducted, each correct response was given a weight of 4 to compensate for guessing and all tests, with "bad items" deleted, were rerun on the FORTAP program to yield more accurate reliability estimates. Punched output, including weighted (X4) scores for each item and final score, was obtained for each student. The cards with weighted scores were matched with cards containing DAT and DRT data. Only those students for whom complete data (pretest, posttest, DAT, and DRT) were available were used for the subsequent analysis.

A factor analysis was run on each test to determine whether or not the items grouped in each concept were loading on similar factors generated by computer programs. The raw data were processed by the BMD03M[5] General Factor Analysis Program. The BMD03M performs a principal component solution and an orthogonal rotation of the factor matrix. Communalities were estimated from the squared multiple correlation coefficients (r^2). Output from the 03M included the mean and standard deviation of each variable, correlation matrix, Eigen-values including cumulative proportions of total variance, Eigenvectors, and a factor matrix. The Harris-Kaiser factor analysis program performed an oblique rotation of the factor matrix produced by the BMD03M program. The number of factors rotated was determined by the number of positive Eigenvectors resulting from the BMD03M. Output from the Harris-Kaiser program included an n x q pattern matrix (where n=number of positive Eigenvectors; q= number of items on the test instrument) which yielded the number of each test item that was loading on each factor.[6]

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[3] See Appendix C.

[4] F. B. Baker and T. J. Martin. FORTAP: A Fortran Test Analysis Package, Laboratory of Experimental Design, Wisconsin Research and Development Center for Cognitive Learning. The University of Wisconsin, March 1, 1968.

[5] W. J. Dixon, ed., BMD Biomedical Computer Programs, (Berkeley: Univeristy of California Press, 1968), pp. 169-184.

Each student's pretest and posttest score on each unit test, together with DAT and DRT data, were run on the BMD01D[7] Simple Data Description program. Output from the 01D included the mean, standard deviation, standard error of the mean, maximum socre, minimum socre, range, and sample size for each test on every unit. These data were then compared to the original FORTAP data to determine whether or not the reduced sample, for whom complete data were available, differed from the original population.

The BMD02R[8] Stepwise Regression program was run on the complete data sample for each test in every unit. This program computed a sequence of multiple linear regression equations in a stepwise manner. At each step one variable was added to the regression equation. The variable added was the one which made the greatest reduction in the error sum of squares. Output from the 02R program included at each step, multiple R, standard error of the estimate, and an analysis of vairance table. In addition, for variables in the equation, the output included the regression coefficient, standard error, and the F-value to remove. For variables not in the equation, the output included tolerance, partial correlation coefficient, and the F-value to enter. After the stepwise regression terminated, means and standard deviations for each variable, a covariance matrix, correlation matrix, list of residuals, and a summary table including for each step, the variable added to the regression equation, multiple r, multiple r^2, increase in r^2, F-value to enter or remove, and the number of independent variables included were printed out.[9]

The BMD05V[10] General Linear Hypothesis program was run on the complete data sample using the posttest as the dependent variable and the pretest as a covariate. Output from the 05V included, for each class, means and standard deviations of the dependent variable, mean of the covariate, sums of squares explained by hypotheses, estimates of the regression coefficient, the pooled regression coefficient, residual sums of squares, F-tests and degrees of freedom for the hypothesis, accuracy of the coefficients, adjusted means for the dependent variable, and the Bartlett Test for homogeneity of variance. The analysis of covariance was used to test the question of differences between classes on adjusted posttest means.

6.See Appendix D.

7.Dixon, BMD, pp. 42-48.

8.Dixon, BMD, pp. 233-257.

9.See Appendix C.

10.Dixon, BMD, pp. 543-557.

The pooled regression coefficient from the 05V was used in calculating the y intercept of the pooled regression line. These data were punched on cards and used in a computer program to calculate and punch a residual gain score for each student in the sample. The computer-punched residual gain scores were run on the BMD01D Simple Data Description program, yielding the mean, standard deviation, standard error, sample size, maximum score, minimum score, and range for each class in the complete-data sample.[11]

To test the hypothesis that students socring low on the Davis Reading Test would show achievement similar to students scoring high on the DRT, posttest scores for each student in each unit test were blocked on the first-25th DRT percentiles, 26th-75th DRT percentiles, and the 76th-99th DRT percentiles. Pretest scores were held as covariates and an analysis of covariance was computed to test for significant differences between the three groups of students.

Appendix E contains the means, by class, for each dependent and independent variable in each unit.

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[11] See Appendix F.

Chapter 3

The Test Population

Teachers who had participated in feedback and training activities with the Biological Sciences Curriculum Study and were known to be using Biological Science: Patterns and Processes were identified and invited to participate in this study. Thirty teachers with 61 classes agreed to participate. A teacher questionnaire[1] was used to secure approximate numbers of students per class, and a teacher rating as to the characteristics (urban, rural, etc.) of the community or communities from which students in the test classes came.

Twenty-five teachers provided sufficient data to be included in the initial phases of the study. Lack of complete data on individual students on particular tests reduced the number of teachers, classes, and students for particular unit tests, as will be described below.

Table 1 provides a numerical description of the initial student group by teacher number. The high influx and outflux of students during the year inflated the total number of students per teacher. The class roll number indicates the total students in the particular teacher's class during the school year 1968-69. Two parts of the Differential Aptitude Test (DAT) and the Davis Reading Test (DRT) were administered in March, 1969. The reduced number, 1211, reflects the spring enrollment and an unknown amount of absenteeism.

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[1] See Appendix I.

Table 1

Number of Students by Teachers, Grade Level, and Community Characteristics

Teacher Number	Community	N by Class Roll	N with DAT Scores	Grade Level					School District Enrollment
				9	10	11	12	?	
102	Urban-lower	61	57	0	55	1	1	0	(Parochial)
104	Suburban	57	44	0	32	6	2	4	25,000
106	Suburban	76	55	0	48	3	1	3	25,000
108	Suburban	86	57	1	47	4	1	4	25,000
111	Urban-middle	48	41	0	37	0	0	4	10,000-24,999
113	Suburban	18	18	0	18	0	0	0	(Parochial)
114	Rural	96	75	0	67	4	2	2	2,500-4,999
115	Suburban	127	90	0	65	22	3	0	25,000
116	Urban-middle	194	138	0	71	34	31	2	25,000
117	Rural	29	27	0	24	2	1	0	25,000
118	Suburban	27	24	13	4	2	5	0	25,000
119	Rural	84	62	0	53	6	3	0	25,000
120	Rural	18	13	0	12	0	0	1	5,000-9,999
122	Urban-middle	45	43	1	40	0	0	2	(Parochial)
123	Suburban	57	49	0	46	3	0	0	25,000
124	Rural	22	18	0	18	0	0	0	2,500-4,999
125	Rural	21	20	0	18	0	0	2	2,500-4,999
127	Urban-middle & Inner City	22	22	0	15	5	0	2	25,000
128	Inner City	24	19	0	19	0	0	0	10,000-24,999
129	Suburban	47	30	0	18	5	3	4	5,000-9,999
130	Suburban & Rural	75	62	0	0	0	0	62	25,000
132	Suburban	134	132	0	132	0	0	0	5,000-9,999
133	Inner City	117	68	0	36	27	5	0	25,000
134	Rural	32	18	2	16	0	0	0	300-2,499
135	Rural	29	29	0	29	0	0	0	300-2,499
Totals 25		1546	1211	17	920	124	58	92	

Classes for the academically unsuccessful student, in this study as shown by the data in Tables 1, 2, and 3, can be characterized as predominatly middle class suburban and rural, in school districts larger that 25,000, but not in the large, central city schools.[2]

Table 2

Number and Percentage of Students, and Number of Teachers Classes by Community Characteristics

Community Characteristics	Number of Teachers	Number of Classes	Students N	Students %
Suburban	9	21	629	40.7
Urban-Middle	3	8	287	18.6
Rural	8	14	331	21.4
Inner City	2	5	141	9.1
Urban Middle & Inner City	1	1	22	1.4
Suburban & Rural	1	3	75	4.9
Urban lower	1	2	61	3.9
Totals	25	54	1546	100.0

Students in the test classes were primarily tenth graders, but some ninth, eleventh, and even twelfth grade students are found in these classes (see Table 1). The mean academic aptitude of the student group is below the mean for the tenth grade normative population. Similarly, reading achievement is below that of the normative population (see Table 3). A rather large turnover can be inferred from the data in Table 1, and a problem of absenteeism can be inferred from the data in Tables 1 and 3. Twelve hundred eleven students took at least one part of the DAT, or DRT, which required four class periods for administering, but complete DAT and DRT data were obtained for only 941 students. This inference is further confirmed by the numbers of students for whom complete pretest, posttest, DAT, and DRT data were obtained for each unit test, to be discussed later in the text of the report.

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[2] See Appendix H.

Table 3

Raw scores on the Differential Aptitude Test (DAT), Form A[1] and the Davis Reading Test (DRT), Form 2C[2] for Students with Complete Scores[3]

Statistic	DAT			DRT	
	VR[4]	NA[5]	VR & NA[6]	C[7]	S[8]
N	941	941	941	941	941
X	16.37	12.93	29.79	21.59	37.36
S.D.	9.71	8.98	17.22	8.18	16.43
S.E.	0.32	0.29	0.56	0.27	0.54
Range	47.00	46.00	85.00	37.00	79.00
Minimum	1.00	-6.00	-1.00	3.00	0.00
Maximum	48.00	40.00	84.00	40.00	79.00

[1] The Psychological Corporation, New York, 1959.

[2] The Psychological Corporation, New York, 1962.

[3] Twenty-five teachers with 41 classes.

[4] Verbal Reasoning, 10th grade boys, $r=0.90$, $\bar{X}=23.1$;
10th grade girls, $r=0.90$, $\bar{X}=23.9$[3]

[5] Numerical Ability, 10th grade boys, $r=0.89$, $\bar{X}=17.5$;
10th grade girls, $r=0.87$. $\bar{X}=16.2$[3]

[6] 10th grade boys, $r=0.90$, $\bar{X}=40.9$; 10th grade girls, $r=0.90$, $\bar{X}=39.7$[3]

[7] 10th graders, $r=0.78$, $X=26.6$[4]

[8] 10th graders, $r=0.86$, $X=47.7$[4]

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3. George K. Bennett, Harold G. Seashore, and Alexander G. Wesman, Manual for the Differential Aptitude Test, 4th Ed. (New York: The Psychological Corporation, 1966), pp. 6-1 to 6-8.

4. Frederick B. Davis and Charlotte C. Davis, Davis Reading Test Manual, Series 1 and 2 (New York: The Psychological Corporation, 1962), pp. 12-15.

Chapter 4

Results and Discussion - Unit I, Ecology

The first unit of study in Biological Science: Patterns and Processes was of selected aspects of ecology. Alternate test forms, A and B[1] were developed to assess twelve major concepts considered important for the academically unsuccessful student. These concepts, specified in behavioral form, and the items on each form designed to assess student understandings of these concepts, are shown in Table 4.

Table 4

Logical Design for Items, Form A and Form B, to Assess Student Understandings of Ecological Concepts, Unit I.

Concept	Test Form A Item	Test Form B Numbers	Total Number of Items
I. Grouping: students should be able to group objects on the basis of common attributes or structure.	2,22	20,21, 22	5
II. Hypothesis: students should recognize that a hypothesis is a possible explanation of something.	20	19	2
III. Control: students should recognize the control variable in an experimental design.	3,24	18,23	4
IV. Graph: students should be able to draw appropriate conclusions when given data in the form of a graph.	4,5	14,15	4
V. Population: students should recognize the characteristics of a population.	17	4	2
VI. Census and Sampling: students should recognize the difference between census and sampling.	11,21	11	3

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[1] See Appendix J.

Table 4 (continued)

Concept	Test Form A	Test Form B	Total Number of Items
	Item	Numbers	
VII. Density: students should be able to calculate density and express it in the proper terminology.	10,18	3,6,7	5
VIII. Food Chains and Webs: students should recognize the order of producers and consumers in a food chain or web.	6,7, 12	2	4
IX. Energy Pyramid: students should recognize that the greatest amount of biomass is found at the producer level and recognize that amount of biomass decreases toward the top of an energy pyramid.	13,14	1,5	4
X. Communities and Ecosystems: students should be able to determine possible outcomes resulting from competition between different populations within a community and recognize the characteristics of communities and ecosystems.	8,9,15, 16,23	8,9,12, 13,16,17	11
XI. Succession: students should be able to determine which plants would grow first after an area was denuded, recognize the characteristics of a climax community and recognize the influence of abiotic factors in succession.	1,19	10,24	4

Complete data for 609 students (21 teachers with 37 classes) were obtained on the Unit 1 tests. Two hundred eighty-nine students took Form A as the pretest and 320 students took Form B as the pretest. The student groups taking the alternate unit test forms were not significantly different ($p < .01$) from each other on the independent variables[2] (see Table 5), but both groups were more able than the total group of

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[2] See Appendix A.

Table 5

Raw Scores on the Verbal Reasoning and Numerical Ability Tests of the Differential Aptitude Test and of the Comprehension and Speed Tests of the Davis Reading Test for Students with Both Pretest and Posttests on Unit I, Ecology.

Statistic	PRE A - POST B					PRE B - POST A				
	DAT[1]			DRT[2]		DAT[1]			DRT[2]	
	VR[3]	NA[4]	T[5]	C[6]	S[7]	VR[3]	NA[4]	T[5]	C[6]	S[7]
N	289	289	289	289	289	320	320	320	320	320
$\bar{X}$	18.45	13.85	32.29	23.15	40.75	18.42	14.59	33.05	22.46	39.72
S.D.	10.25	9.23	17.94	8.04	16.48	10.01	9.39	17.90	8.29	17.00
S_e	0.60	0.54	1.06	0.47	0.97	0.56	0.53	1.00	0.46	0.95
Maximum Score	47.00	40.00	84.00	39.00	75.00	48.00	39.00	81.00	40.00	79.00
Minimum Score	2.00	-6.00	2.00	5.00	11.00	3.00	-5.00	-1.00	4.00	9.00
Range	45.00	46.00	82.00	34.00	65.00	45.00	44.00	82.00	36.00	70.00

1 Differential Aptitude Test, Form A
2 Davis Reading Test, Form 2C
3 Verbal Reasoning
4 Numerical Ability
5 Sum of VR + NA
6 Level of Comprehension
7 Speed

participating students on the DAT and the DRT (see Table 3, page 17).

Results

The Hoyt analysis of variance reliability and standard error for Form A were 0.70 and 8.2 (raw score weighted x 4), respectively. For Form B, reliability was 0.72 and standard error, 7.9. Item analysis[3] showed all items to be positive discriminators with biserial correlations ranging from 0.1704 to 0.7000.

Students performed well on the pretests (a mean of 75 percent correct on Form A, 70 percent on Form B), as the text was designed to provide an introduction to biology through the study of ecological relationships presumed to be relatively familiar to this group of students.

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[3] See Appendix B.

The first question to be explored was, Were gains made in achievement on the group of items designed to assess each of the twelve concepts for this unit of study?

Preliminary data in the form of percent possible gain[4] were provided to the team of writers revising the text and laboratory materials. Gains were found for ten of the twelve concepts.[5] Two concepts, grouping, and census and sampling showed losses and were examined for problems in text presentation. A particularly confused presentation of census and sampling, which was reflected directly in the low achievement of students on the three items designed to measure the concept, was quite evident.[6] Revisions of the text[7] were made in both of these areas.

The second question to be tested was, Is there a significant difference in the level of achievement on the Unit 1 posttests between classes using Patterns and Processes when adjusted for differences in pretest scores?

To test this question, an analysis of covariance was performed on students' posttest scores in 37 classes, holding pretest scores as the covariate (see Tables 6 and 8).

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[4] See Appendix C for the method of computation.

[5] See Appendix C (Table of Percent Possible Gain).

[6] See Appendix J, Unit 1, Form A, Items 11 and 21, Form B, Item 11.

[7] Biological Science: Patterns and Processes, 2nd Edition (New York: Holt, Rinehart and Winson, in press).

Table 6

N, Means, Standard Deviations, and Adjusted Means of 37 Classes on Pretest A - Posttest B, Analysis of Covariance.

Class #	N	Mean Posttest B	Standard Deviation Posttest B	Adjusted Mean Posttest B	Mean Pretest A
1021	12	51.0000	14.2829	52.0061	55.0833
1032	14	52.9286	12.5175	56.9213	50.0714
1092	8	59.1250	13.1956	61.0746	53.5000
1111	8	62.5000	11.0970	63.5557	55.0000
1131	6	68.6667	8.9144	66.6435	60.1667
1141	6	54.0000	8.2946	62.0080	43.3333
1142	3	62.6667	8.3267	63.1265	56.0000
1143	7	60.5714	14.5012	64.4363	50.2857
1144	4	49.2500	10.8743	49.1139	57.0000
1145	5	47.2000	10.3537	56.2409	41.6000
1153	8	63.1250	12.0646	67.4582	49.5000
1161	5	57.6000	15.3883	58.0598	56.0000
1163	6	66.0000	10.3537	68.1482	53.1667
1164	9	62.3333	14.0357	60.8068	59.3333
1165	9	56.4444	11.2150	60.4797	50.0000
1171	8	55.5000	13.9284	57.5986	53.2500
1181	8	57.5000	19.1162	63.0250	47.5000
1201	3	41.3333	10.0665	46.5604	48.0000
1221	9	54.7778	11.3333	56.5618	53.7778
1222	8	58.7500	12.6914	59.1353	56.1250
1231	18	53.2222	19.0249	54.8739	54.0000
1241	9	59.5556	7.8599	55.9764	62.7778
1251	7	62.8571	16.2832	61.5292	59.0000
1271	2	56.0000	16.9706	67.1862	38.0000
1281	6	41.8333	12.5286	52.7216	38.5000
1291	6	57.3333	9.3524	58.4884	54.8333
1292	8	50.0000	15.4180	52.0986	53.2500
1301	5	48.2000	18.7770	52.3545	49.8000
1302	3	56.0000	21.1660	57.2544	54.6667

Table 6 (continued)

Class #	N	Mean Posttest B	Standard Deviation Posttest B	Adjusted Mean Posttest B	Mean Pretest A
1303	7	44.5714	11.6456	44.3502	57.1429
1321	10	73.6000	11.9555	64.5253	72.0000
1322	11	80.7273	12.8770	69.2689	76.0000
1323	10	72.8000	6.4773	60.6266	77.2000
1324	11	76.0000	11.7303	64.7584	75.6364
1325	11	69.8182	10.9345	60.0934	73.0909
1341	8	47.7500	14.4395	57.9678	39.6250
1351	11	54.5455	17.1835	54.1385	57.4546

The results of the analysis of covariance, indicating a significant ($p < .01$) difference between classes on the adjusted means of posttest B, Unit I, are summarized in Table 7.

Table 7

ANCOVA Table for Differences Between Adjusted Posttest Means on Posttest B, Unit I.

Source	d.f.	mean square	F
Treatments	36	233.77588	1.95215**
Error	251	119.75307	

**Significant at the .01 level, $F_{.01\ (36,251)} = 1.79$

Table 8

N, Means, Standard Deviations, and Adjusted Means of 37 Classes on Pretest B - Posttest A, Analysis of Covariance.

Class #	N	Mean Posttest A	Standard Deviation Posttest A	Adjusted Mean Posttest A	Mean Pretest B
1021	11	56.0000	11.3137	60.8846	44.6364
1032	10	60.4000	13.2598	65.0844	45.0000
1092	6	68.0000	16.9706	71.7669	46.6667
1111	11	57.0909	13.9818	60.0738	48.0909
1131	6	62.1667	11.3564	60.4286	56.6667
1141	5	55.2000	9.9599	51.6269	60.0000
1142	4	65.0000	10.0000	64.1794	55.0000
1143	4	65.0000	6.0000	68.5834	47.0000
1144	6	52.6667	6.8896	54.9656	49.3333
1145	6	67.3333	13.9523	70.7332	47.3333
1153	8	67.0000	10.4198	66.3859	54.6250
1161	3	61.3333	10.0665	55.5583	64.0000
1163	8	64.2500	10.9642	66.3195	49.7500
1164	11	68.3636	15.3315	67.8433	54.4546
1165	8	73.5000	12.2708	72.5418	55.2500
1171	12	48.0000	14.8691	55.7122	39.5000
1181	11	62.9091	12.4053	66.7427	46.5455
1201	5	59.2000	13.0843	66.0864	41.0000
1221	14	58.8571	13.3524	63.3056	45.4286
1222	11	65.4546	10.7737	63.6331	56.8182
1231	18	66.7778	13.5106	68.3121	50.7222
1241	7	61.7143	6.0474	60.1073	56.4286
1251	6	65.3333	3.2660	67.4487	49.6667
1271	3	50.6667	2.3094	59.2046	38.0000
1281	5	51.6000	20.3544	60.3581	37.6000
1291	7	58.8571	18.1423	65.7436	41.0000
1292	2	70.0000	14.1421	70.8309	52.0000
1301	9	53.3333	10.9545	56.6109	47.5556
1302	10	53.9000	8.0478	55.4466	50.7000

Table 8 (continued)

Class #	N	Mean Posttest A	Standard Deviation Posttest A	Adjusted Mean Posttest A	Mean Pretest B
1303	9	50.6667	19.6977	53.6996	48.0000
1321	15	73.8667	10.1268	64.8620	69.8667
1322	14	78.5714	7.4598	67.5666	73.5000
1323	13	75.3846	7.8053	64.5280	73.2308
1324	13	77.2308	12.6896	66.8823	72.3077
1325	13	74.7692	7.3729	66.9615	67.2923
1341	4	62.0000	16.1659	61.7299	54.0000
1351	12	49.5833	21.3007	56.3780	41.1667

The results of the analysis of covariance, indicating a significant ($p < .01$) difference between classes on the adjusted means of posttest A, Unit I, are summarized in Table 9.

Table 9

ANCOVA Table for Differences Between Adjusted Posttest Means on Posttest A, Unit I.

Source	d.f.	mean square	F
Treatments	36	219.7249	1.8304**
Error	282	120.0402	

**Significant at the .01 level, $F_{.01\ (36,282)} = 1.63$

A hypothesis proposed in this research was that reading ability, as measured by the DRT Comprehension score, would have no affect on student success on the posttest instruments. In other words, success on the posttest would not depend on a student's reading ability. To test this hypothesis, the following question was asked, Is there a significant difference between groups when posttest scores, with the pretest scores held as a covariate, are blocked on DRT Comprehension percentile rankings? To test this question, individual student's scores on both posttest forms were pooled and placed in three blocks: first-25th DRT percentiles, 26th-75th DRT percentiles, and 76th-99th DRT percentiles (see Table 10). An analysis of covariance, indicating a significant ($p < .01$) difference between blocks, was computed on the blocked data (see Table 11).

Table 10

N, Means, Standard Deviations, and Adjusted Means of 3 Blocks of Students Based on DRT Comprehension Percentile Rankings, Unit I.

Percentile Ranking	N	Posttest Mean	Standard Deviation	Adjusted Mean Posttest	Pretest Mean
1-25	187	51.1765	13.8174	56.8331	43.4652
26-75	261	61.7893	13.5510	61.5937	55.5058
76-99	161	72.2236	11.5645	65.9704	67.9689

Table 11

ANCOVA Table for Differences Between Adjusted Posttest Means Blocked on DRT Comprehension Percentile Rankings, Unit I.

Source	d.f.	mean square	F
Blocks	2	2367.0258	17.5230**
Error	605	135.0813	

**Significant at .01 level, $F_{.01\ (2,605)} = 4.61$

Discussion

The results of the analysis of covariance on adjusted means of both posttest A and posttest B indicate that there is a significant difference ($p < .01$) in achievement between classes in Unit I. The exact reasons for this difference are undoubtedly complex. But, based on data presented and discussed in Appendix E, a hypothesis that the teacher variable may be playing an extremely important part in this difference can be proposed. It is also possible that student variables such as class attendance may contribute to these between class differences.

The results of the analysis of covariance on the adjusted pooled means blocked on DRT Comprehension percentiles indicate that reading ability, as determined by DRT Comprehension scores, does have a significant ($p < .01$) effect on success with the posttest instruments in Unit I. These results do not support the hypothesis that students with low DRT Comprehension scores will score as high as students with high DRT Comprehension scores. If the nullification of the effect of reading comprehension on achievement is to be attained, less reading, or a reduction in reading complexity, and/or a complete change in writing style will have to be considered in future revisions of *Patterns and Processes*. It is extremely doubtful, however, that this nullification could ever be achieved, assuming the validity of the test instrument as a measure of criterion performance. The reason for this is the high level of intercorrelation that exists between reading comprehension, reading speed, general aptitude, as measured by the DAT, and posttest scores.[8] A person with a high DRT Comprehension score has a high probability of ranking high in general aptitude and would therefore be expected to score higher on an achievement instrument than a person with a low DRT Comprehension score. The effect of writer efforts to reduce the effect of reading comprehension in the Revised Edition of *Patterns and Processes* should be investigated.

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[8] See Appendix E.

Chapter 5

Results and Discussion - Unit II, Cell Energy Processes

The second unit of study in Biological Sciences: Patterns and Processes was of selected topics of cell energy processes. Alternate test forms, A and B[1] were developed to assess fourteen major concepts considered important for the academically unsuccessful student. These concepts, specified in behavioral form, and the items on each form designed to assess student understandings of these concepts are shown in Table 12.

Table 12

Logical Design for Items, Form A and Form B, to Assess Student Understandings of Concepts of Cell Energy Processes, Unit II.

Concept	Test Form A	Test Form B	Total Number of Items
	Item	Numbers	
I. The first Law of Thermodynamics. Energy is the ability to do work. Energy can be neither created or destroyed. Energy can be transformed from one form to another. The student should be able to select a definition of energy from a list of comparable definitions. Given an experimental situation the student should be able to name the various forms of energy involved in the transformations.	1	1,2	3
II. The processes of burning and respiration are similar. The student should be able to select the formulation for the process of burning or respiration from a list of similar formulae.	2	3,4,5	4

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[1] See Appendix J.

Table 12 (continued)

Concept	Test Form A Item	 B Numbers	Total Number of Items
II. (continued) The student should be able to complete the formula for burning or respiration when given an incomplete formula.			
III. The energy requirements of an organism varies with its activity. The student should be able to match a list of energy requirements with a list of organismal activities.	3,4	6,7,8	5
IV. Energy in foods is measurable in calories. Given the formula for calculating calories and experimental data the student should be able to calculate the number of calories produced by a particular food.	5,6	9,10	4
V. Enzymes control chemical reactions in living things. Enzymes speed up chemical reactions. Enzymes can be used over and over again. Students should be able to state the behavioral characteristics of enzymes. The student should be able to select from a list those conditions which either cause an enzyme to work faster, or those which decrease its activity.	7,8,9,10,11,12	11,12,13,14,15,16	12

Table 12 (continued)

Concept	Test Form A Item	Test Form B Numbers	Total Number of Items
VI. Living things are made of cells. Cells contain a cell membrane, a nucleus, and cytoplasm. Given a picture of a cell, the student should be able to label the nucleus, cytoplasm and cell membrane. Given a list of cell structures, the student should be able to select those common to all living cells.	13,14	--	2
VII. Foods enter cells by diffusion. Diffusion is determined by particle size, size of openings in membranes, solubility of membranes by the diffusor, and expenditure of energy by the cell. Given a picture of a cell membrane and various size particles, the students should be able to choose those particles which will pass through the membrane. Given a picture of a cell membrane and a varying number of particles on either side of the membrane, the student should be able to indicate the direction of flow of the particles. The students should be able to choose from a list of factors, those which influence the passage of molecules through a membrane.	15,16, 17,18	17,18,19, 20,21,22, 23	11
VIII. The process of digestion changes large molecules to small ones. The student should be able to identify digestion as the process which changes large molecules to smaller ones.	19	24	2

Table 12 (continued)

Concept	Test Form A Item	 B Numbers	Total Number of Items
VIII. (continued) Given the word "digestion" the student should be able to provide the definition.			
IX. Green plants produce glucose by the process of photosynthesis. Students should be able to select the formula for photosynthesis from a list of similar formulae. Students should be able to complete the formula for photosynthesis when given an incomplete formula.	20,21	25	3
X. Chemical compounds have an orderly structure. Given the number of bonds of various elements, the student should be able to properly construct a molecule model. Students should be able to match the names of common elements with the symbols for these elements.	22,23	26	3
XI. The breakdown of glucose in a cell releases energy usable by the organism. Students should be able to name glucose as the food cells use for the production of energy.	24	27,28	3
XII. Organisms store energy for future use in ATP molecules.	25,26	29,30	4

Table 12 (continued)

Concept	Test Form A Item	Test Form B Numbers	Total Number of Items
XII. (continued) The student should be able to identify ATP as the energy storage molecule of the cell. The student should be able to state that ATP releases stored energy when a phosphate molecule is removed, producing ATP.			
XIII. All living things carry out the same basic life functions. The student should be able to select from a list of functions those common to all living things.	27,28, 29	--	3
XIV. Interpretations of data can lead to new understandings about living things. Interpretations can be changed when new data is available.	30	--	1

Complete data for 504 students (18 teachers with 31 classes) were obtained on the Unit II tests. Two hundred fifty-nine students took form A as the pretest and 245 students took form B as the pretest. The student groups taking the alternate unit test forms were not significantly different ($p < .01$) from each other on the independent variables[2] (see Table 13), but both groups were more able than the total group of participating students on the DAT and the DRT (see Table 3, page 12).

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[2] See Appendix A.

Table 13

Raw Scores on the Verbal Reasoning and Numerical Ability Tests of the Differential Aptitude Test and of the Comprehension and Speed Tests of the Davis Reading Test for Students with Both Pretest and Posttests on Unit II, Cell Energy Processes.

Statistic	PRE A - POST B					PRE B - POST A				
	DAT[1]			DRT[2]		DAT[1]			DRT[2]	
	VR[3]	NA[4]	T[5]	C[6]	S[7]	VR[3]	NA[4]	T[5]	C[6]	S[7]
N	259	259	259	259	259	245	245	245	245	245
$\bar{X}$	18.05	14.04	32.08	22.39	38.36	18.44	14.95	33.39	22.86	40.12
S.D.	9.66	9.41	17.62	8.02	16.48	10.04	9.37	17.93	8.25	16.65
S_e	0.60	0.58	1.09	0.50	1.02	0.64	0.60	1.14	0.53	1.06
Maximum Score	48.00	40.00	81.00	40.00	79.00	46.00	38.00	84.00	37.00	75.00
Minimum Score	2.00	-5.00	0.00	4.00	0.00	1.00	-4.00	-1.00	3.00	7.00
Range	46.00	45.00	81.00	36.00	79.00	45.00	42.00	85.00	34.00	68.00

1 Differential Aptitude Test, Form A
2 Davis Reading Test, Form 2C
3 Verbal Reasoning
4 Numerical Ability
5 Sum of VR + NA
6 Level of Comprehension
7 Speed

Results

The Hoyt analysis of variance reliability and standard error for Form A were 0.73 and 9.42 (raw score weighted x 4), respectively. For Form B, reliability was 0.74 and standard error 9.41. Item analysis[3] showed all items to be positive discriminators with biserial correlations ranging from 0.1688 to 0.6357.

Students performed well on the pretests (a mean of 51 percent correct on Form A and 54 percent on Form B), but not as well as on the Unit I, Ecology pretest. This result seems reasonable, however, since cell energy processes are not nearly as familiar to students as ecological principles.

The first question to be explored was, Were gains made in achievement on the group of items designed to asses each of the fourteen concepts for this unit of study?

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[3] See Appendix B.

Preliminary data in the form of percent possible gain were provided to the team of writers revising the text and laboratory materials. Gains were found for thirteen of the fourteen concepts.[4] One concept, the breakdown of glucose in a cell releases energy usable by the organism[5], showed a loss and was examined for problems in text presentation. A revision of the text[6] was made in this area.

The second question to be tested was, Is there a significant difference in the level of achievement on the Unit II posttests between classes using Patterns and Processes when adjusted for differences in pretest scores?

To test this question, an analysis of covariance was performed on students' posttest scores in 31 classes, holding pretest scores as the covariate (see Tables 14 and 16).

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[4] See Appendix C.

[5] See Appendix J, Unit II, Form A, Item 24, Form B, Items 27 and 28.

[6] Biological Science: Patterns and Processes, 2nd Edition (New York: Holt, Rinehart and Winston, in press).

Table 14

N, Means, Standard Deviations, and Adjusted Means of 31 Classes on Pretest A - Posttest B, Analysis of Covariance

Class #	N	Mean Posttest B	Standard Deviation Posttest B	Adjusted Mean Posttest B	Mean Pretest A
1021	13	59.2308	9.9846	59.9650	46.6923
1032	15	58.6667	10.7615	59.9810	44.5333
1052	6	62.0000	10.3537	63.7263	43.0000
1072	3	57.3333	10.0665	56.1040	54.0000
1081	3	68.0000	4.0000	68.3828	48.0000
1092	3	68.0000	34.8712	69.4576	44.0000
1131	8	59.5000	9.4264	57.8340	55.6250
1141	6	60.6667	18.8326	61.6765	45.6667
1143	5	54.4000	19.3080	53.9230	51.2000
1144	5	61.0000	16.1555	62.8338	42.6000
1145	4	54.0000	24.1109	53.1737	52.5000
1152	9	61.4444	16.9640	63.4992	41.7778
1153	6	72.6667	18.1402	72.2434	51.0000
1154	10	75.7000	10.5415	74.6856	53.2000
1171	9	62.4444	21.2727	61.9913	51.1111
1181	11	57.8182	10.9345	59.0315	44.9091
1192	4	55.2500	15.1300	56.2374	45.7500
1201	7	56.7143	11.7575	59.9377	37.4286
1221	10	74.9000	12.0596	77.0831	41.3000
1222	10	65.6000	10.5325	66.5202	46.0000
1231	18	65.0556	12.9591	64.6323	51.0000
1241	7	72.2857	11.1013	73.2059	46.0000

Table 14 (continued)

Class #	N	Mean Posttest B	Standard Deviation Posttest B	Adjusted Mean Posttest B	Mean Pretest A
1251	7	55.5714	12.8044	57.2210	43.2857
1301	6	62.6667	16.3299	64.1243	44.0000
1302	8	59.5000	16.0624	61.3271	42.6250
1303	6	64.6667	15.0555	63.3477	54.3333
1321	13	85.0000	19.2267	79.9261	68.3077
1322	13	92.9231	12.6653	90.4122	58.7692
1323	13	75.7500	16.1815	73.2219	58.8333
1324	11	93.9091	12.3649	91.3606	58.9091
1351	11	57.1818	15.3416	59.0791	42.3636

The results of the analysis of covariance, indicating a significant ($p<.01$) difference between classes on the adjusted means of posttest B, Unit II, are summarized in Table 15.

Table 15

ANCOVA Table for Differences Between Classes on the Adjusted Posttest Means on Posttest B, Unit II.

Source	d.f.	mean square	F
Treatments	30	774.3744	3.79939**
Error	227	203.8154	

**Significant at the .01 level, $F_{.01\ (30,227)} = 1.70$

Table 16

N, Means, Standard Deviation, and Adjusted Means of 31 Classes on Pretest B - Posttest A, Analysis of Covariance.

Class #	N	Mean Posttest A	Standard Deviation Posttest A	Adjusted mean Posttest A	Mean Pretest B
1021	11	67.4546	12.9643	68.6569	54.0000
1032	14	61.3571	11.8556	63.0819	52.0714
1052	6	61.6667	19.8662	62.8239	54.1667
1072	5	50.8000	12.9306	51.2440	56.8000
1081	6	60.0000	8.0000	59.9383	58.6667
1092	6	55.5000	7.7910	56.5218	54.6667
1131	6	60.0000	10.4307	59.3966	60.6667
1141	5	55.2000	11.0996	56.2940	54.4000
1143	6	55.3333	5.8878	56.1746	55.3333
1144	5	63.2000	6.5727	63.2106	58.4000
1145	6	56.0000	12.8996	56.4801	56.6667
1152	8	58.6250	12.5691	60.1660	52.7500
1153	8	63.0000	14.1421	61.4599	64.1250
1154	5	54.0000	15.3883	55.2232	55.4000
1171	8	53.7500	8.1020	56.2728	49.1250
1181	10	52.2000	9.7274	54.9192	48.4000
1192	3	40.0000	6.9282	43.5499	45.3333
1201	5	57.6000	7.7974	59.0191	53.2000
1221	7	62.8571	11.2462	63.5565	55.8571
1222	8	73.5000	14.1724	75.5150	51.0000
1231	15	66.0000	13.9130	65.7397	59.4000
1241	4	58.0000	7.6594	60.8276	48.0000

Table 16 (continued)

Class #	N	Mean Posttest A	Standard Deviation Posttest A	Adjusted Mean Posttest A	Mean Pretest B
1251	6	56.0000	13.3866	57.9247	51.3333
1301	8	54.2500	12.8480	56.5020	50.1250
1302	6	52.0000	24.0000	54.8276	48.0000
1303	7	46.0000	6.2183	47.1250	54.2857
1321	15	85.7333	23.6023	80.1099	79.2000
1322	13	97.5385	17.5718	93.3652	73.8462
1323	9	88.8889	22.5191	85.5769	70.6667
1324	12	83.6667	21.7395	79.3163	74.5000
1351	13	53.5385	9.4217	54.0324	56.6154

The results of the analysis of covariance, indicating a significant ($p < .01$) difference between classes on the adjusted means of posttest A, Unit II, are summarized in Table 17.

Table 17

ANCOVA Table for Differences Between Classes on the Adjusted Posttest Means on Posttest A, Unit II.

Source	d.f.	mean square	F
Treatments	30	888.1556	4.41721**
Error	214	201.0669	

**Significant at the .01 level, $F_{.01\ (30,214)} = 1.70$

A hypothesis proposed in this research was that reading ability, as measured by the DRT Comprehension score, would have no affect on student success on the posttest instruments. In other words, success on the posttest would not depend on a student's reading ability. To test this hypothesis, the following question was asked, Is there a significant difference between groups when posttest scores, with the pretest scores held as a covariate, are blocked on DRT Comprehension percentile rankings? To test this question, individual student's scores on both posttest forms were pooled and placed in three blocks: first-25th DRT percentiles, 26th-75th DRT percentiles, and 76th-99th DRT percentiles (see Table 18). An analysis of covariance, indicating a significant ($p < .01$) difference between blocks was computed on the blocked data (see Table 19).

Table 18

N, Means, Standard Deviations, and Adjusted Means of 3 Blocks of Students Based on DRT Comprehension Percentile Rankings, Unit II.

Percentile Ranking	N	Posttest Mean	Standard Deviation	Adjusted Mean Posttest	Pretest Mean
1-25	166	55.2771	13.2942	57.3685	46.1446
26-75	208	65.3990	16.1508	65.5245	53.3558
76-99	131	79.8779	19.1524	77.0285	64.2672

Table 19

ANCOVA Table for Differences Between Adjusted Posttest Means Blocked on DRT Comprehension Percentile Rankings, Unit II.

Source	d.f.	mean square	F
Blocks	2	11185.5513	45.14942**
Error	501	247.7452	

**Significant at .01 level, $F_{.01\ (2,501)} = 4.61$

Discussion

The results of the analysis of covariance on adjusted means of both posttest A and posttest B indicate that there is a significant difference ($p < .01$) in achievement between classes in Unit II. As in Unit I, the exact reasons for this difference are undoubtedly complex. However, based on data presented and discussed in Appendix E, a hypothesis that the teacher variable may be playing an extremely important part in this difference can also be proposed for Unit II. It may be too, that student variables such as class attendance may contribute to these between class differences.

The results of the analysis of covariance on the adjusted pooled means blocked on DRT Comprehension percentiles indicate that reading ability, as determined by DRT Comprehension scores, has a significant ($p < .01$) effect on success with the posttest instruments in Unit II. These results for Unit II, as was the case in Unit I, do not support the hypothesis that sutdents with low DRT Comprehension socres will achieve as well as students with high DRT Comprehension scores. As was previously explained[7], due to the high intercorrelation that exists between general aptitude and reading comprehension, it will be extremely difficult to nullify the effect of reading comprehension on success on the test instrument. This result further emphasizes the importance of investigating the effect of writer efforts to reduce the effect of reading comprehension in the Revised Edition of Patterns and Processes.

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[7] See page 22.

Chapter 6

Results and Discussion - Unit III, Reproduction and Development

The third unit of study in Biological Science: Patterns and Processes was of selected aspects of reproduction and development. Alternate test forms, A and B[1] were developed to assess eleven major concepts considered important for the academically unsuccessful student. These concepts, specified in behavioral form, and the items on each form designed to assess student understandings of these concepts, are shown in Table 20.

Table 20

Logical Design for Items, Form A and Form B, to Assess Student Understandings of Reproduction and Development Concepts, Unit III.

Concept	Test Form A Item	Test Form B Numbers	Total Number of Items
I. All life comes from pre-existing life. Given a display of Pasteur's spontaneous generation experiments the student should be able to select the parts of the experiment which are the controls. Given a display of Pasteur's spontaneous generation experiment the student should be able to select those portions which indicate that life comes only from pre-existing life.	1,2,3	1,2	5
II. The process of reproduction insures the continuation of life. Given a list of life processes the student should select reproduction as the one that provides for a new generation.	4	3,22	3

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[1] See Appendix J.

Table 20 (continued)

Concept	Test Form A Item	 B Numbers	Total Number of Items
III. Asexual reproduction produces offspring closely resembling the parents. Variation in the offspring is due to environmental variation not genetic variation. Given a series of drawings the student should be able to select those which illustrate the process of asexual reproduction.	5,6,9	4,5,11	6
IV. Sexual reproduction involves the fusion of reproductive cells called gametes. The student should be able to state that the union of an egg and a sperm is necessary to the process of sexual reproduction.	8,20	14,18	4
V. A new individual begins development after two gametes, an egg and a sperm, unite. Given a series of drawings of the development of the frog embryo the student should be able to arrange them into the proper order of their occurrence. Given the environmental conditions under which an embryo develops the student should be able to indicate the effect each of the conditions has upon the developing embryo.	7,11, 12	10,12	5
VI. Growth of a multicellular organism follows a definite, observable pattern.	15,16, 17,18, 21,22	13,19, 20,21	10

Table 20 (continued)

Concept	Test Form A Item	 B Numbers	Total Number of Items
VI. (continued) Given a drawing of a 3-day old chick embryo the student should be able to identify the somites, the head, the yolk membrane, the spinal cord and the heart. Given a series of drawings or photos of chick embryos the student should be able to arrange these in proper order according to age. Given a list of structures that develop in the chick embryo the student should be able to arrange those in their proper order.			
VII. Flowering plants have evolved specialized structures to insure the union of the sperm and egg. Given a picture of a flower the student should be able to identify various structures, i.e., petals, pistil, stamens, pollen, and ovule. Given the name of a flower structure the student should be able to give the function of the mentioned structure.	23,24, 25	15,16, 17,29	7
VIII. Favorable environmental conditions are necessary for embryonic development. Given a list of environmental conditions the student should be able to select those most favorable to the development of an embryo. The student should be able to name those favorable environmental conditions required by all developing embryos.	13	23,24	3

Table 20 (continued)

Concept	Test Form		Total Number of Items
	A	B	
	Item	Numbers	
IX. Differentiation of cells provides a new organism with the many kinds of cells necessary for the life of an organism. Given a definition of differentiation the student should be able to provide the term.	14	6,30	3
X. Cells increase in number by the process of mitosis. Given an improperly sequenced series of pictures illustrating the process of mitosis the student should be able to order these in the proper sequence. Given the number of chromosomes in a mother cell the student should be able to state the number of chromosomes in the resulting daughter cells. Given the structure of a mature cell the student should be able to select the nucleus and chromosomes as those structures most actively involved in mitosis.	10,19	7,25	4
XI. Mammalian reproduction and development involves the interplay of many systems and hormones. Given a list of hormones the student should be able to select those involved in the menstrual cycle. The student should be able to select from a list of hormones, those hormones produced by the pituitary gland. Given a series of disordered events in the fertilization of an egg and the subsequent implantation and development of the embryo, the	27,28 29,30	8,9,26, 27,28	9

Table 20 (continued)

Concept	Test Form A Item	B Numbers	Total Number of Items
XI. (continued) student should be able to place them in proper order. Given a picture of a mammalian embryo the student should be able to identify various structures, i.e., placenta, amnion, umbilical cord.			

Complete data for 446 students (21 teachers with 29 classes) were obtained on the Unit III tests. Two hundred twenty students took Form A as the pretest and 226 students took Form B as the pretest. The student groups taking the alternate unit test forms were not significantly different ($p < .01$) from each other on the independent variables[2] (see Table 21), but both groups were less able than the total group of participating students on the DAT and the DRT (see Table 3, page 12).

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[2] See Appendix A.

Table 21

Raw Scores on the Verbal Reasoning and Numerical Ability Tests of the Differential Aptitude Test and of the Comprehension and Speed Tests of the Davis Reading Test for Students with Both Pretest and Posttests on Unit III, Reproduction and Development.

Statistic	PRE A - POST B					PRE B - POST A				
	DAT[1]			DRT[2]		DAT[1]			DRT[2]	
	VR[3]	NA[4]	T[5]	C[6]	S[7]	VR[3]	NA[4]	T[5]	C[6]	S[7]
N	220	220	220	220	220	226	226	226	226	226
$\bar{X}$	15.24	11.11	26.35	20.27	34.47	15.04	10.92	25.96	20.61	34.02
S.D.	7.53	6.95	12.55	7.26	13.32	7.63	7.56	13.35	7.67	14.08
S_e	0.51	0.47	0.85	0.49	0.90	0.51	0.50	0.89	0.51	0.94
Maximum Score	40.00	33.00	70.00	36.00	69.00	43.00	35.00	78.00	36.00	70.00
Minimum Score	1.00	-6.00	-1.00	5.00	12.00	2.00	-5.00	2.00	3.00	0.00
Range	39.00	39.00	71.00	31.00	57.00	41.00	40.00	76.00	33.00	70.00

1 Differential Aptitude Test, Form A
2 Davis Reading Test, Form 2C
3 Verbal Reasoning
4 Numerical Ability
5 Sum of VR + NA
6 Level of Comprehension
7 Speed

This result is different than those for the Units I and II populations, which were slightly more able than the total group of participating students. This drop is attributed to one teacher with several classes that did not turn in any data for his students on Unit III. The mean scores on the DAT and DRT for this particular teacher's classes were very high, and their subsequent withdrawal from Unit III is the cause of the drop in mean scores.

Results

The Hoyt analysis of variance reliability and standard error for Form A were 0.71 and 9.3 (raw score weighted x 4), respectively. For Form B, reliability was 0.74 and standard error 8.9. Item analysis[3] showed all items to be positive discriminators with biserial correlation ranging from 0.0308 to 0.9031.

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[3] See Appendix B.

Students performed reasonably well on the Unit III pretests, scoring a mean of 53 percent on both Form A and Form B.

The first question to be investigated in Unit III was, Were gains made in achievement on the group of items designed to assess each of the eleven concepts for this unit of study?

Preliminary data in the form of percent possible gain were provided to the team of writers revising the text and laboratory materials. Gains were found in ten of the eleven concepts.[4] One concept, Reproduction Insures Continuation[5] showed a loss and was examined for problems in text presentation. A revision of the text[6] was made in this area.

The second question to be investigated was, Is there a significant difference in the level of achievement on the Unit III posttests between classes using Patterns and Processes when adjusted for differences in pretest scores?

To test this question, an analysis of covariance was performed on students' posttest scores in 29 classes, holding pretest scores as the covariate (see Tables 22 and 24).

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[4] See Appendix C.

[5] See Appendix J, Unit III, Form A, Item 4, Form B, Items 3 and 22.

[6] Biological Science: Patterns and Processes, 2nd Edition (New York: Holt, Rinehart and Winston, in press).

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Table 22

N, Means, Standard Deviations, and Adjusted Means of 29 Classes on Pretest A - Posttest B, Analysis of Covariance

Class #	N	Mean Posttest B	Standard Deviation Posttest B	Adjusted Mean Posttest B	Mean Pretest A
1021	10	86.8000	10.5071	84.7823	68.4000
1032	16	71.3750	16.2270	71.9986	63.0625
1052	11	81.9091	13.8018	81.1241	65.9091
1061	4	85.2500	4.7170	92.2140	50.2500
1072	4	75.0000	10.5198	74.5411	65.2500
1081	6	77.3333	7.0048	79.0601	60.8333
1092	8	71.0000	14.3328	66.8297	72.7500
1101	6	71.5000	22.5544	69.1029	69.1667
1131	8	81.0000	14.6190	78.9328	68.5000
1141	5	68.2000	20.0050	72.6155	55.4000
1144	4	76.0000	10.8321	81.6031	53.0000
1145	5	87.2000	15.5949	78.8481	81.2000
1152	7	74.1429	22.8796	74.5853	63.4286
1153	8	88.6250	11.4010	84.4547	72.7500
1154	5	77.0000	13.9642	72.0132	74.4000
1171	8	67.5000	22.0584	75.8249	47.5000
1181	12	62.3333	21.6557	67.8540	53.1667
1201	5	82.4000	19.5141	85.3309	58.4000
1221	8	74.5000	19.1162	75.1546	63.0000
1222	8	75.8750	15.9682	75.9729	64.1250
1231	17	82.4118	15.8077	83.2410	62.6471
1241	6	84.6667	6.4083	79.2180	75.3333

Table 22 (continued)

Class #	N	Mean Posttest B	Standard Deviation Posttest B	Adjusted Mean Posttest B	Mean Pretest A
1251	7	83.4286	14.5012	78.0741	75.1429
1292	6	74.0000	20.5134	76.7990	58.6667
1301	7	75.4285	16.5616	73.2554	68.7143
1302	6	72.1667	16.4489	72.9037	62.8333
1303	6	73.3333	15.1085	74.4828	62.0000
1341	7	60.1429	18.1882	61.7165	61.1429
1351	10	64.0000	22.7059	61.7844	68.8000

The results of the analysis of covariance, indicating a significant ($p < .05$) difference between classes on the adjusted means of posttest B, Unit III, are summarized in Table 23.

Table 23

ANCOVA Table for Differences Between Classes on the Adjusted Posttest Means on Posttest B, Unit III.

Source	d.f.	mean square	F
Treatments	28	361.72453	1.64838*
Error	190	220.04985	

*Significant at the .05 level, $F_{.05\ (28,190)} = 1.48$

Table 24

N, Means, Standard Deviations, and Adjusted Means of 29 Classes on Pretest B - Posttest A, Analysis of Covariance.

Class #	N	Mean Posttest A	Standard Deviation Posttest A	Adjusted Mean Posttest A	Mean Pretest B
1021	14	71.5000	12.3957	75.5755	57.7857
1032	11	78.3636	20.3729	81.8949	58.8182
1052	5	80.0000	6.3246	76.1616	72.8000
1061	8	80.3750	12.2117	76.6947	72.5000
1072	10	66.1000	18.7762	64.7389	68.1000
1081	6	86.0000	8.6718	78.3665	80.0000
1092	7	76.7143	16.7602	71.4151	75.5714
1101	7	67.4286	23.4866	68.8309	62.8571
1131	7	86.8571	7.1970	85.2476	68.5714
1141	5	65.6000	15.3883	66.4000	64.0000
1144	5	74.6000	18.0222	74.5676	65.2000
1145	6	85.6000	14.5877	81.6562	73.0000
1152	9	80.8889	12.4544	79.9905	67.2222
1153	7	81.7143	18.0159	77.6951	73.1429
1154	9	82.3333	13.0767	77.5110	74.6667
1171	10	72.9000	16.0031	76.4408	58.8000
1181	10	75.6000	10.2328	73.6591	69.2000
1201	4	74.2500	17.0172	81.3751	52.0000
1221	10	83.3000	16.6403	85.2596	61.8000
1222	10	89.6000	11.0272	86.7630	70.9000
1231	15	79.6667	12.1988	82.1533	60.8000
1241	6	86.0000	9.3808	78.0151	80.6667
1251	7	69.8571	22.2743	69.0758	67.0000

Table 24 (continued)

Class #	N	Mean Posttest A	Standard Deviation Posttest A	Adjusted Mean Posttest A	Mean Pretest B
1292	4	75.0000	15.4488	74.7458	66.0000
1301	6	29.3333	27.5584	71.4510	61.5000
1302	7	81.4286	7.3679	86.7465	55.4286
1303	5	71.2000	19.4731	70.7350	66.4000
1341	4	67.2500	20.3859	72.2667	56.0000
1351	13	64.0769	20.0519	68.6071	56.9231

The results of the analysis of covariance, indicating a significant ($p < .05$) difference between classes on the adjusted means of posttest A, Unit III, are summarized in Table 25.

Table 25

ANCOVA Table for Differences Between Classes on the Adjusted Posttest Means on Posttest A, Unit III.

Source	d.f.	mean square	F
Treatments	28	302.63700	1.64422*
Error	196	184.06114	

*Significant at the .05 level, $F_{.05\ (28,196)} = 1.48$

The third question to be investigated was, Is there a significant difference between groups when posttest scores, with the pretest held as a covariate, are blocked on DRT Comprehension percentile rankings?

To test this question, individual student's scores on both posttest forms were pooled and placed in three blocks: first-25th DRT percentiles, 26th-75th DRT percentiles, and 76th-99th DRT percentiles (see Table 26). An analysis of covariance, indicating a significant ($p < .01$) difference between blocks, was computed on the blocked data (see Table 27).

Table 26

N, Means, Standard Deviations, and Adjusted Means of 3 Blocks of Students Based on DRT Comprehension Percentile Rankings, Unit III.

Percentile Ranking	N	Posttest Mean	Standard Deviation	Adjusted Mean Posttest	Pretest Mean
1-25	176	67.9716	17.6300	70.7767	57.8693
26-75	209	79.5120	14.1129	78.5423	67.3684
76-99	61	88.5246	11.7170	83.7535	76.9344

Table 27

ANCOVA Table for Differences Between Adjusted Posttest Means Blocked on DRT Comprehension Percentile Rankings, Unit III.

Source	d.f.	mean square	F
Blocks	2	4139.38957	20.73191**
Error	442	199.6627	

**Significant at the .01 level, $F_{.01\ (2,442)} = 4.61$

Discussion

The results of the analysis of covariance on adjusted means of both posttest A and posttest B indicate that there is a significant difference ($p < .05$) in achievement between classes in Unit III. This result for Unit III further strengthens the hypothesis proposed for Units I and II that the teacher variable may be playing an extremely important part in this difference. If is possible too, that student variables such as class attendance may contribute to these between class differences.

The results of the analysis of covariance on the adjusted pooled Unit III posttest means block on DRT Comprehension percentiles were the same as those obtained with Units I and II. Therefore, the student with a low DRT Comprehension score would not be expected to score as high on the Unit III posttests as would a person with a higher DRT Comprehension score. As in Units I and II, the hypothesis that students with low level DRT Comprehension scores would perform as well on the posttests as a student with a higher DRT Comprehension score, is not supported by the data for Unit III.

Chapter 7

Results and Discussion - Unit IV, Genetic Continuity

The fourth unit of study in Biological Science: Patterns and Processes was of selected aspects on genetics. Alternate test forms, A and B[1] were developed to assess six major concepts considered important for the academically unsuccessful student. These concepts, specified in behavioral form, and the items on each form designed to assess student understandings of these concepts, are shown in Table 28.

Table 28

Logical Design for Items, Form A and Form B, to Assess Student Understandings of Genetic Continuity Concepts, Unit IV.

Concept	Test Form A	Test Form B	Total Number of Items
	Item	Numbers	
I. Inherited traits can be modified by the environment. Given the results of raising two genetically identical organisms in two different sets of environmental conditions the student will indicate that any visible differences in the organisms is due to the differences in the environments. Given a definition of "genetic inheritance" the student will supply the correct term. Given the term "genetic inheritance" the student will be able to state the correct definition	1,2,6, 15,16	1,11, 20,26	9
II. A knowledge of the rules and assumptions of probability can aid in the understanding of heredity.	3,7,8, 17	2,3,12, 13	8

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[1] See Appendix J.

Table 28 (continued)

Concept	Test Form A Item	 B Numbers	Total Number of Items
II. (continued) Given the probability of the occurence of two separate events, the student will be able to predict the change of these two events occuring together. Given the number of alternatives for the occurrence of any one event, the student should be able to predict the chance of this event occuring by itself. Given the change of any single event to occur the student should be able to predict the chance of the same event occuring again.			
III. Chromosomes follow a regular pattern in the formation of gametes. Given the number of chromosomes found in a gamete producing cell the student should be able to predict the number of chromosomes present in any gamete produced. Given the number of chromosomes found in the egg and sperm of a given species the student should be able to predict the number of chromosomes in the resulting zygote. Given a list of words the student will select "meiosis" as the process gametes in sexually reproducing organisms.	4,18,25	4,14,21	6
IV. The inheritance of traits by organisms follows definite predictable patterns. All traits are not inherited by the same definite predictable patterns.	5,9,10,11,12,19,20,22,23	7,8,15,16,17,18,21,22,23	18

Table 28 (continued)

Concept	Test Form A Item	Test Form B Numbers	Total Number of Items
IV. (continued)			
Given the traits present in the parents and the traits found in the resulting offspring the student will be able to pick the trait which is dominant over the other trait.			
Given that all of the offspring of several generations are identical with respect to some trait, the student should state that they are genetically identical.			
Given the traits present in the parents and the traits found in the resulting offspring the student will be able to pick the trait which is recessive to the other trait.			
Given the traits present in the parents and the traits found in the resulting offspring the student will be able to state that neither trait is dominant over the other.			
Given the sex of a human being the student will be able to state if the individual has an XX or XY chromosome makeup.			
Given which trait is inherited as a dominant or a recessive trait, the student will be able to predict which trait will be visible in the first generation, and which traits will be visible in the second generation.			
Given a pedigree of inheritance and the information as to which trait is dominant and which trait is recessive, the student should be able to indicate the pairs of genes, for this trait, present in each individual shown in the pedigree.			

Table 28 (continued)

Concept	Test Form A Item	Test Form B Numbers	Total Number of Items
IV. (continued) Given several pedigress of interitance the student will be able to differentiate between the pedigrees autosomal inheritance and those showing sex chromosomal inheritance. Given the information that a trait is recessive the student will state that an individual requires two genes for this trait to have the trait appear in the individual. Given the information that a trait is dominant the student will state that an individual must have only one gene for this trait to have the trait appear in the individual. Given the information that a trait is linked to the sex chromosome, the student will state that a male requires only one gene for the trait to have the trait appear, but that a female requires two genes in order to have the trait appear. Given the genetic make-up for an individual for a given trait the student will be able to state that one gene of each gene pair has come from each parent.			
V. The genes occur on the chromosomes. Given various structures of the cell the student will indicate that the chromosomes are the site of the gene.	26	24	2
VI. Evidence indicates that the chromosomes are made of DNA. Molecules of DNA are probably synonomous with the gene. DNA exerts chemical control over the cell and	13,14, 24,27	9,10, 19,25	8

Table 28 (continued)

Concept	Test Form A	 B	Total Number of Items
	Item	Numbers	
VI. (continued)			
controls the inheritance of characteristics by organisms.			
Given the names of several biochemical molecules the student will identify DNA as the molecule found in the chromosome.			
Given a list of nucleotides, such as adnine, quanine, cytocine, and thymine, the student will be able to state the nucleotide that bonds with the state nucleotide to form a pair.			
Given a diagram of the DNA molecule the student will be able to identify the major components of the molecule as a sugar, a phosphate and a nucleotide.			
Given some sequences of nucleotides in different DNA molecules the student will be able to select those sequences which provide the same genetic information.			
Given the structures of a cell the student will state that the chromosome is the structure which contains DNA.			

Complete data for 402 students (16 teachers and 25 classes were obtained on the Unit IV tests. One hundred eighty-nine students took Form A as the pretest and 213 students took Form B as the pretest. The student groups taking the alternate unit test forms were not significantly different ($p < .01$) from each other on the independent variables[2] (see Table 29), but both groups were less able than the total group of participating students on the DAT and the DRT (see Table 3, page 17), as was the case in Unit III. The same reason for the drop applies - the loss of one teacher with several classes who scored high on both the DAT and the DRT tests.

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[2] See Appendix A.

Table 29

Raw Scores on the Verbal Reasoning and Numerical Ability Tests of the Differential Aptitude Test and of the Comprehension and Speed Tests of the Davis Reading Test for Students with Both Pretest and Posttests on Unit IV, Genetic Continuity.

Statistic	PRE A - POST B					PRE B - POST A				
	DAT[1]			DRT[2]		DAT[1]			DRT[2]	
	VR[3]	NA[4]	T[5]	C[6]	S[7]	VR[3]	NA[4]	T[5]	C[6]	S[7]
N	189	189	189	189	189	213	213	213	213	213
$\bar{X}$	15.08	11.31	26.24	20.03	33.65	14.36	11.31	25.66	19.79	33.60
S.D.	6.87	6.92	11.75	7.55	14.10	7.43	7.35	12.94	7.28	13.75
S_e	0.50	0.50	0.86	0.55	1.03	0.51	0.50	0.89	0.50	0.94
Maximum Score	42.00	31.00	70.00	36.00	70.00	43.00	35.00	78.00	36.00	67.00
Minimum Score	2.00	-5.00	2.00	3.00	7.00	1.00	-4.00	-1.00	5.00	9.00
Range	40.00	36.00	68.00	33.00	63.00	42.00	39.00	79.00	31.00	58.00

1 Differential Aptitude Test, Form A
2 Davis Reading Test, Form 2c
3 Verbal Reasoning
4 Numerical Ability
5 Sum of VR + NA
6 Level of Comprehension
7 Speed

Results

The Hoyt analysis of variance reliability and standard error for Form A were 0.68 and 9.3 (raw score weighted x 4), respectively. For Form B, reliability was 0.66 and standard error 8.7. Item analysis[3] showed all items to be positive discriminators with biserial correlations ranging from 0.1379 to 0.6072.

Students performed reasonably well on the Form A, Unit IV pretests, scoring a mean of 53 percent, but on the Form B pretest, the mean score was only 37 percent, indicating a more difficult instrument.

The first question to be investigated in Unit IV was, Were gains made in achievement on the group of items designed to assess each of the six major concepts and their subconcepts for this unit of study?

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[3] See Appendix B.

Preliminary data in the form of percent possible gain were provided to the team of writers revising the text and laboratory materials. Gains were found in all six concepts[4] and their subconcepts.

The second question to be investigated was, Is there a significant difference in the level of achievement on the Unit IV posttests between classes using Patterns and Processes when adjusted for differences in pretest scores?

To test this question, an analysis of covariance was performed on students' posttest scores in 25 classes, holding pretest scores as the covariate (see Tables 30 and 32).

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[4] See Appendix C.

Table 30

N, Means, Standard Deviations, and Adjusted Means of 25 Classes on Pretest A - Posttest B, Analysis of Covariance.

Class #	N	Mean Posttest B	Standard Deviation Posttest B	Adjusted Mean Posttest B	Mean Pretest A
1021	7	45.1429	18.1423	43.1800	49.4286
1032	14	46.1429	10.9042	45.7717	44.3571
1052	8	49.5000	11.0970	49.0056	44.7500
1061	7	43.7143	9.5344	40.9444	52.0000
1072	7	31.0000	11.1505	30.0684	46.1429
1141	4	47.2500	9.2150	46.0494	47.0000
1143	5	50.6000	10.0896	52.7801	36.2000
1152	6	44.1667	16.8810	46.4185	36.0000
1153	8	43.5000	14.2528	43.8687	42.0000
1154	8	42.0000	19.5959	43.1533	39.5000
1171	6	32.0000	12.1326	35.0365	33.5000
1181	8	51.2500	11.3484	48.9509	50.5000
1201	5	38.4000	9.2087	38.8942	41.6000
1221	12	54.7500	16.3770	54.5171	43.9167
1222	5	52.8000	17.9778	50.2184	51.4000
1231	19	47.8421	19.8222	48.1777	42.1053
1241	5	52.0000	9.3808	50.7366	47.2000
1251	7	47.1429	14.5078	49.7085	35.0000
1291	7	43.4286	10.9371	44.0663	41.1429
1292	4	26.0000	9.5219	28.2518	36.0000
1301	7	52.7143	18.4275	52.9484	42.4286
1302	7	40.0000	14.4222	39.7858	43.8571

Table 30 (continued)

Class #	N	Mean Posttest B	Standard Deviation Posttest B	Adjusted Mean Posttest B	Mean Pretest A
1303	6	46.6667	7.8655	45.9891	45.3333
1333	4	30.2500	4.1933	32.7372	35.2500
1351	13	38.4615	9.5970	37.9128	44.9231

The results of the analysis of covariance, indicating a significant ($p < .05$) difference between classes on the adjusted means of posttest B, Unit IV, are summarized in Table 31.

Table 31

ANCOVA Table for Differences Between Classes on the Adjusted Posttest Means on Posttest B, Unit IV.

Source	d.f.	mean square	F
Treatments	24	325.65546	1.77076*
Error	163	183.90742	

*Significant at the .05 level, $F_{.05\ (24,163)} = 1.52$

Table 32

N, Means, Standard Deviations, and Adjusted Means of 25 Classes on Pretest B - Posttest A, Analysis of Covariance.

Class #	N	Mean Posttest A	Standard Deviation Posttest A	Adjusted Mean Posttest A	Mean Pretest B
1021	14	61.4286	14.6850	58.5803	38.4286
1032	16	60.7500	12.2393	59.9368	34.6875
1052	8	56.7500	16.2722	54.4748	37.3750
1061	9	56.4444	13.4825	55.5821	34.7778
1072	6	41.3333	10.0133	37.9929	39.3333
1141	6	42.0000	12.0665	43.0113	31.3333
1143	6	56.6667	10.2502	57.3154	32.0000
1152	6	45.6667	14.3341	50.9391	23.5000
1153	6	49.3333	20.1858	49.2567	33.3333
1154	9	57.3333	12.0000	53.6302	40.0000
1171	5	42.6000	15.9938	43.2487	32.0000
1181	11	56.4546	17.4320	59.3286	27.9091
1201	5	55.2000	8.1976	62.1588	20.4000
1221	10	49.6000	14.7513	50.5751	31.4000
1222	12	51.0000	8.8831	51.7847	31.7500
1231	20	49.2500	15.5492	48.5338	34.5000
1241	10	60.1000	13.5684	60.5311	32.4000
1251	7	52.5714	12.7391	53.6087	31.2857
1291	4	46.0000	23.2092	51.4085	23.2500
1292	5	64.8000	21.6148	65.0135	32.8000
1301	7	42.8571	14.9156	44.4384	30.2857
1302	6	62.1667	20.6922	59.7328	37.6667

Table 32 (continued)

Class #	N	Mean Posttest A	Standard Deviation Posttest A	Adjusted Mean Posttest A	Mean Pretest B
1303	8	49.0000	19.2131	46.1128	38.5000
1333	5	45.8000	12.6570	48.1394	28.8000
1351	12	46.0000	15.7711	45.7421	33.6667

The results of the analysis of covariance, indicating a significant $(p < .01)$ difference between classes on the adjusted means of posttest A, Unit IV, are summarized in Table 33.

Table 33

ANCOVA Table for Differences Between Classes on the Adjusted Posttest Means on Posttest A, Unit IV.

Source	d.f.	mean square	F
Treatments	24	352.68237	1.92018**
Error	187	183.67181	

**Significant at the .01 level, $F_{.01\ (24,187)} = 1.79$

The third question to be investigated was, Is there a significant difference between groups when posttest scores, with the pretest held as a covariate, are blocked on DRT Comprehension percentile rankings?

To test this question, individual student's scores on both posttest forms were pooled and placed in three blocks: first-25th DRT percentiles, 26th-75th DRT percentiles, and 76th-99th DRT percentiles (see Table 34). An analysis of covariance, indicating a significant $(p < .01)$ difference between blocks, was computed on the blocked data (see Table 35).

Table 34

N, Means, Standard Deviations, and Adjusted Means of 3 Blocks of Students Based on DRT Comprehension Percentile Rankings, Unit IV.

Percentile Ranking	N	Posttest Mean	Standard Deviation	Adjusted Mean Posttest	Pretest Mean
1-25	173	43.3642	14.8880	43.9565	33.1734
26-75	177	51.5819	14.3041	51.2749	40.3277
76-99	52	58.8077	15.8276	57.8819	45.2500

Table 35

ANCOVA Table for Differences Between Adjusted Posttest Means Blocked on DRT Comprehension Percentile Rankings, Unit IV.

Source	d.f.	mean square	F
Blocks	2	4182.58320	19.36780**
Error	398	215.95552	

**Significant at the .01 level, $F_{.01\ (2,398)} = 4.61$

Discussion

The results of the analysis of covariance on adjusted means of both posttests indicate that there is a significant difference in achievement between classes in Unit IV ($p < .05$ for posttest B and $p < .01$ for posttest A). This same result was obtained for each unit of study in Patterns and Processes and strongly suggests that the hypothesis that the teacher variable is extremely important should be investigated. It is also possible that student variables such as class attendance may contribute to these between class differences.

The results of the analysis of covariance on the adjusted pooled Unit IV posttest means blocked on DRT Comprehension percentiles were the same as those obtained in each of the preceeding units of study - there was a significant difference ($p < .01$) between the blocks of students in achievement on the Unit IV posttest. In all four units of study in Patterns and Processes, students with high DRT percentile rankings scored significantly higher on the posttests than those students with low DRT percentile rankings. These results do not support the hypothesis that students with low DRT percentile rankings would score as well as students with high DRT percentile rankings on the posttest instruments used in this study.

Chapter 8

Impact of Evaluation on Patterns and Processes

The chief purpose of the evaluation project was to locate weaknesses in the first edition of Patterns and Processes so that the writing team could improve the revised edition. Accordingly the tests were analyzed concept by concept. Percentage correct on the pretest and percentage correct on the posttest were computed for each concept in each unit. If either the posttest level of performance or the pretest-posttest gain were judged to be unsatisfactory for a concept, a further, more detailed analysis was completed. Each item was examined to determine whether it contained a flaw which could have misled students or whether it tested beyond the objectives of the curriculum.

If the items assessing a concept were acceptable, the next task was to diagnose the reasons for poor student performance. Analysis of student errors on test items was always a step in diagnosis, and often proved helpful. Next, the curriculum was examined to find the places where the student was supposed to have learned the concept. Finally, revisions were made which would hopefully bring student performance up to standard.

There were approximately twenty substantial changes made in the curriculum because of learning problems identified from the evaluation data. Several instances will be detailed for illustration.

1. When asked on the posttest what factor biologists usually use to classify organisms, 81 percent of the students selected structure. However, another question asked students to choose an example of structure classification from among four alternatives. Only 58 percent were successful. Nearly 16 percent thought that "large animal vs. small animal" was an example of classification by structure and 21 percent chose "live in deserts vs. live near lakes." These data indicated that many students had a poorly developed concept of structural classification. Consequently, a brief "Discussion Pattern" was included in the revised edition in which the teacher listed one at a time a series of examples of classification (e.g. animals with internal skeletons vs. animals with external skeletons, green insects vs. brown insects, plants with hand-shaped leaves vs. plants with feather-shaped leaves). The students were asked to judge whether the examples illustrated structural classification or some other form of classification.

2. Students generally were not as successful (less than 50 percent correct) on test items that required computing population per unit area, calories per gram, or indeed, any problem involving ratios and proportions. A self-instructional program was prepared which it is hoped will teach most students who can multiply and divide decimal fractions to solve ratio and proportion problems.

3. When asked to select an example of a population, only 43 percent of the students answered correctly; 32 percent chose "large broad-leafed trees including maples, beeches, and sycamores." This indicated too broad a concept of population. The remedy was to include several steps in the suggested teacher dialogue to emphasize that a population involves only the members of a single species.

4. Only 47 percent of the students were able to correctly identify the by-products of combustion and respiration; 23 percent failed to include water, whereas 19 percent chose oxygen in addition to carbon dioxide and heat. Consequently, additional emphases were placed on the by-products of combustion in two places within the Cell Energy unit.

5. The data indicated that the ATP cycle was completely rewritten to spell out the steps in the cycle more carefully and make it more readable. Furthermore, a review exercise on the ATP cycle was developed.

6. The data showed that most students had very little comprehension of Mendelian genetics. For instance, one question asked students to indicate the phenotypic proportions of the offspring of a homozygous dominant parent and a homozygous recessive parent. Only 17 percent responded correctly on the pretest while 33 percent were correct on the posttest. This is a substantial gain, but, of course, the posttest level was still unacceptable. On the posttest, 41 percent still believed that half the F_1 generation would show the phenotype associated with the homozygous recessive genotype. The genetics unit was completely rewritten. Special attention was given to a more detailed development of the concepts of Mendelian genetics.

Chapter 9

Conclusions and Recommendations

I. Conclusions

1. Academically unsuccessful students using the text Biological Science: Patterns and Processes made gains in terms of percent possible gain in 38 of the 42 major concepts measured. In the four areas where no gains were noted, revisions in the text have been made.

2. There was a significant difference between classes in the level of student achievement on adjusted posttest scores for each posttest form in each unit. While the variables influencing these results may be complex, data, as presented in Appendix E, indicates that teacher performance may play an important part in these differences. Student variables, such as class attendance, may also contribute to differences between classes.

3. Despite the intent of the authors of Patterns and Processes to reduce the effect of reading comprehension on achievement, students with high DRT Comprehension percentile rankings scored significantly higher on the posttest instruments than those with low DRT Comprehension percentile rankings. Because of the high intercorrelation that exists among reading comprehension, general aptitude and success on multiple-choice type instruments, the choice of such instruments for evaluating student achievement precludes the determination of any real reduction of the effects of reading skills on achievement.

4. Despite alternate forms of posttests designed to measure identical concepts, different factors affected the level of success on the alternate posttest forms in every unit except that on Reproduction and Development.

5. It appears that the amount of variance attributable to the teacher increases throughout the year. Evidence also indicates that more variance may be attributable to the effect of the teacher when using Patterns and Processes than when the teacher operates in conventional classroom situations.

6. Data suggest that all teachers using Biological Science: Patterns and Processes be given a comprehension teacher training program in order that the students can derive the maximal benefit from the materials.

7. Students did less well when dealing with questions requiring computations of ratios, proportions, or density. This seems to indicate more stress needs to be placed on the quantitative aspects of the material.

8. Students had less success with certain areas of the material in Patterns and Processes than was anticipated. This indicates the necessity of either strengthening the material or insuring that teachers make special efforts to do so in their presentations. Specific areas that need strengthening include (a) generalizations from graphic data, (b) identification of controls in an experiment, (c) citing examples of structural classification, (d) the concept of a population, (e) by-products of combustion and respiration, (f) the ATP cycle, (g) Mendelian genetics.

9. Students were very successful (<80 percent) with some areas of the material in Patterns and Processes. These areas needed little or no modification in the revised edition of the text. Specific areas where high success was achieved include (a) interrelationships of food webs and chains, (b) interpreting data, (c) function of enzymes, (d) recognition of chemical symbols, (e) identification of embryonic structures, (f) identification of flower parts, (g) sequence of embryonic development, (h) inheritance of genes from parents.

II. Recommendations

In terms of the design and outcomes of the study, certain recommendations can be made for the conduct of similar studies in the future. They include the following:

1. That evaluation data be collected one full year in advance of a rewriting session that plans to utilize the data for materials revision. This would allow adequate time to compute, analyze, and interpret the data and also to present it in some meaningful form to the creative group.

2. That test items be prepared and reviewed by groups of writers and not by one individual. This should result in an increase of the validity and reliability of the test instruments.

3. That more items per concept be included in the test instruments. An item sampling design would greatly increase the number of items per concept and result in a better basis for interpretation of student success.

4. That data be collected on how the materials were used in the classroom. We strongly recommend that descriptive information be gathered from teachers by using questionnaires asking the teacher to list each of the activities in each unit, by page. The teacher should be asked to indicate whether his class did or did not complete each activity. If he modified or supplemented the activity, the teacher should be asked to describe these modifications.

5. That videotaping of classroom interaction be used in future studies of Patterns and Processes to determine the effect of the teacher variable in the classroom.

6. That the amount of variance attributable to teacher effect when using Patterns and Processes be thoroughly investigated due to the data summarized in conclusion five.

7. That future studies be conducted over a school year to determine whether or not the amount of variance attributable to the teacher using Patterns and Processes increases during the school year.

8. That means be provided to secure complete data for each student so that within class analyses can be conducted on the maximum number of students possible.

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APPENDIX A

t-TEST RESULTS

Appendix Table 1

Results of t-Tests for Differences Between Independent Variables, Unit I

DAT VERBAL

Mean	N	Standard Deviation	t
18.4464	289	10.2469	.0089
18.4232	320	10.0088	

$t < 1.960$ - no significant difference

DAT NUMERICAL

Mean	N	Standard Deviation	t
13.8478	289	9.2326	1.1160
14.6906	320	9.3856	

$t < 1.960$ - no significant difference

DAT TOTAL

Mean	N	Standard Deviation	t
32.2941	289	17.9453	.5218
33.0531	320	17.9034	

$t < 1.960$ - no significant difference

DRT COMPREHENSION

Mean	N	Standard Deviation	t
23.1522	289	8.0380	1.0515
22.4562	320	8.2863	

$t < 1.960$ - no significant difference

DRT SPEED

Mean	N	Standard Deviation	t
40.7543	289	16.4846	1.1160
39.7187	320	16.9944	

$t < 1.960$ - no significant difference

Appendix Table 2

Results of t-Tests for Differences Between Independent Variables, Unit II

DAT VERBAL

Mean	N	Standard Deviation	t
18.0502	259	9.6642	.4429
18.4390	246	10.0441	

$t < 1.960$ - no significant difference

DAT NUMERICAL

Mean	N	Standard Deviation	t
14.0386	259	9.4080	1.0919
14.9512	246	9.3685	

$t < 1.960$ - no significant difference

DAT TOTAL

Mean	N	Standard Deviation	t
32.0888	259	17.6173	.8223
33.3902	246	17.9260	

$t < 1.960$ - no significant difference

DRT COMPREHENSION

Mean	N	Standard Deviation	t
22.3861	259	8.0207	.6508
22.8577	246	8.2492	

$t < 1.960$ - no significant difference

DRT SPEED

Mean	N	Standard Deviation	t
38.6255	259	16.4798	1.0119
40.1179	246	16.6503	

$t < 1.960$ - no significant difference

Appendix Table 3

Results of t-Tests for Differences Between Independent Variables, Unit III

DAT VERBAL

Mean	N	Standard Deviation	t
15.2364	220	7.5270	.2678
15.0442	226	7.6320	

t < 1.960 - no significant difference

DAT NUMERICAL

Mean	N	Standard Deviation	t
11.1136	220	6.9467	.2811
10.9204	226	7.5609	

t < 1.960 - no significant difference

DAT TOTAL

Mean	N	Standard Deviation	t
26.3500	220	12.5495	.3142
25.9646	226	13.3513	

t < 1.960 - no significant difference

DRT COMPREHENSION

Mean	N	Standard Deviation	t
20.2682	220	7.2620	.4841
20.6106	226	7.6738	

t < 1.960 - no significant difference

DRT SPEED

Mean	N	Standard Deviation	t
34.4682	220	13.3178	.3472
34.0177	226	14.0807	

t < 1.960 - no significant difference

Appendix Table 4

Results of t-Tests for Differences Between Independent Variables, Unit IV

DAT VERBAL

Mean	N	Standard Deviation	t
15.0847	189	6.8730	1.0139
14.3615	213	7.4261	

$t < 1.960$ - no significant difference

DAT NUMERICAL

Mean	N	Standard Deviation	t
11.3122	189	6.9154	.0084
11.3052	213	7.3456	

$t < 1.960$ - no significant difference

DAT TOTAL

Mean	N	Standard Deviation	t
26.2381	189	11.7542	.4678
25.6620	213	12.9356	

$t < 1.960$ - no significant difference

DRT COMPREHENSION

Mean	N	Standard Deviation	t
20.0370	189	7.5529	.3283
19.7934	213	7.2804	

$t < 1.960$ - no significant difference

DRT SPEED

Mean	N	Standard Deviation	t
33.6508	189	14.0956	.0392
33.5962	213	13.7548	

$t < 1.960$ - no significant difference

APPENDIX B

ITEM ANALYSIS RESULTS

Appendix Table 5

Item Analysis Results - Unit I, Posttest A

Item #	Difficulty	R biserial
1	.5587	.2998
2	.8083	.5059
3	.8463	.3525
4	.7719	.6053
5	.7636	.5726
6	.8711	.6942
7	.8099	.5642
8	.7587	.6064
9	.6017	.4860
10	.4050	.5854
11	.2116	.3513
12	.8215	.6223
13	.8529	.6018
14	.1388	.1704
15	.8347	.6675
16	.4430	.4066
17	.4264	.5703
18	.3438	.1907
19	.7736	.5890
20	.6711	.6343
21	.5719	.4953
22	.5752	.5670
23	.6198	.4601
24	.6479	.5590

Appendix Table 6

Item Analysis Results - Unit I, Posttest B

Item #	Difficulty	R biserial
1	.3495	.5038
2	.4816	.4308
3	.7274	.5620
4	.4197	.3864
5	.6940	.4099
6	.5468	.6419
7	.6003	.6803
8	.2876	.4369
9	.8712	.6602
10	.3980	.3268
11	.2458	.2977
12	.4967	.3412
13	.6488	.3087
14	.7860	.5948
15	.8679	.6683
16	.4816	.3362
17	.3194	.3083
18	.5886	.6260
19	.6087	.4753
20	.8445	.6249
21	.8729	.7000
22	.5485	.5400
23	.4849	.4897
24	.7609	.5049

Appendix Table 7

Item Analysis Results - Unit II, Posttest A

Item #	Difficulty	R biserial
1	.4963	.5818
2	.4682	.4225
3	.8277	.4682
4	.4682	.5971
5	.2734	.3766
6	.4045	.4335
7	.6891	.4152
8	.8090	.4300
9	.3876	.4939
10	.3333	.4113
11	.6536	.1688
12	.5131	.3636
13	.5749	.5282
14	.6199	.5320
15	.6461	.4973
16	.3670	.4581
17	.7060	.5128
18	.5037	.3690
19	.3483	.4589
20	.5899	.3694
21	.5993	.4292
22	Omitted	--
23	.7753	.4839
24	.4794	.4726

Appendix Table 7 (continued)

Item #	Difficulty	R biserial
25	.4307	.3681
26	.2322	.4651
27	.3989	.4385
28	.2940	.6357
29	.3071	.4946
30	.3446	.5893

Appendix Table 8

Item Analysis Results - Unit II, Posttest B

Item #	Difficulty	R biserial
1	.4117	.3939
2	.5019	.3880
3	.5508	.5182
4	.6222	.3905
5	.3327	.5372
6	.8515	.4340
7	.7500	.4680
8	.6579	.5311
9	.3891	.2247
10	.3816	.3887
11	.5132	.3830
12	.7820	.4139
13	.7726	.5854
14	.6861	.4659
15	.5752	.4069
16	.4793	.3718
17	.3233	.2987
18	.6711	.5345
19	.4323	.5054
20	.4586	.5215
21	.7970	.6112
22	.7030	.5129
23	.7105	.6259
24	.6391	.5309

Appendix Table 8 (continued)

Item #	Difficulty	R biserial
25	.3421	.3983
26	.2180	.4558
27	.4925	.5609
28	Omitted	--
29	.2650	.4937
30	.2932	.2451

Appendix Table 9

Item Analysis Results - Unit III, Posttest A

Item #	Difficulty	R biserial
1	.4113	.2847
2	.5172	.4560
3	.2906	.2812
4	.7192	.4818
5	.4113	.3963
6	.3916	.3645
7	.6970	.2412
8	.6798	.4837
9	.5813	.4436
10	.3473	.4510
11	.3842	.4929
12	.7414	.4882
13	.5222	.3115
14	.2463	.1489
15	.7635	.5075
16	.9030	.8632
17	.8153	.3763
18	.7783	.4970
19	.5788	.4007
20	.8990	.6181
21	.7956	.6086
22	.5616	.4614
23	.8892	.9031
24	.7685	.6734

Appendix Table 9 (continued)

Item #	Difficulty	R biserial
25	.5690	.4942
26	.5936	.3596
27	.6601	.4165
28	.5665	.4470
29	.8498	.7316
30	.3892	.4090

Appendix Table 10

Item Analysis Results - Unit III, Posttest B

Item #	Difficulty	R biserial
1	.2822	.0308
2	.6667	.4682
3	.6131	.4434
4	.4915	.4940
5	.4282	.4896
6	.3017	.1981
7	.3674	.4624
8	.6156	.4163
9	.4550	.4198
10	.6934	.4783
11	.2530	.3087
12	.3771	.4148
13	.8929	.6738
14	.6107	.5297
15	.8832	.6487
16	.7007	.5191
17	Omitted	--
18	.7737	.4919
19	.9440	.7747
20	.9465	.7611
21	.6861	.3296
22	.6034	.5545
23	.6399	.4971
24	.7397	.6085

Appendix Table 10 (continued)

Item #	Difficulty	R biserial
25	.7445	.6564
26	.5061	.4243
27	.5280	.5084
28	.8978	.7501
29	.8297	.6350
30	.6715	.5904

Appendix Table 11

Item Analysis Results - Unit IV, Posttest A

Item #	Difficulty	R biserial
1	.2480	.1379
2	.7755	.5268
3	.3995	.2549
4	.5039	.4749
5	.6527	.5462
6	.7023	.4134
7	.6841	.5311
8	.5849	.1552
9	.3969	.4220
10	.4282	.4178
11	.4386	.3599
12	.5770	.3174
13	.2611	.2362
14	.4883	.5893
15	.6397	.5040
16	.6632	.5893
17	.3003	.4049
18	.5953	.2829
19	.6371	.5611
20	.3368	.5734
21	.3368	.4901
22	.5796	.5335
23	.2167	.2453
24	.4909	.5122

Appendix Table 11 (continued)

Item #	Difficulty	R biserial
25	.3342	.4088
26	.7154	.4718
27	.7311	.4844

Appendix Table 12

Item Analysis Results - Unit IV, Posttest B

Item #	Difficulty	R biserial
1	.3949	.4816
2	.3256	.6038
3	.3205	.3837
4	.4256	.3883
5	.3615	.3790
6	.3615	.2724
7	.5744	.5018
8	.7667	.4267
9	.7256	.4608
10	.5205	.5145
11	.4718	.4526
12	.4513	.5643
13	.3154	.2565
14	.3026	.2371
15	.5410	.5717
16	Omitted	--
17	Omitted	--
18	.4231	.4666
19	.5077	.4967
20	.7846	.5456
21	.4872	.2531
22	.4974	.5874
23	.4744	.4981
24	Omitted	--

Appendix Table 12 (continued)

Item #	Difficulty	R biserial
25	.4051	.4023
26	.5769	.3367

APPENDIX C

PERCENT POSSIBLE GAIN TABLES

Percent Possible Gain Calculation

The "percent possible gain" statistic adjusts for the asymptotic or ceiling effect and allows a meaningful comparison of gains. It is computed as follows:

$$\text{percent possible gain} = \frac{\text{Actual (raw) gain}}{\text{Possible gain}} = \frac{\text{Post-Pre}}{\text{1-Pre}}$$

Appendix Table 13

Percent Possible Gain Calculations, Unit I

Concept	Percent Correct Pretest	Percent Correct Posttest	Percent Possible Gain
Grouping	78.1%	76.9%	- 5.7%
Hypothesis	46.7%	62.0%	28.7%
Control	52.5%	62.3%	20.6%
Graphs	71.1%	80.8%	33.3%
Population	30.5%	40.3%	14.1%
Census + Sampling	31.2%	30.7%	- 0.7%
Density	42.3%	48.4%	10.6%
Population Change	63.8%	68.9%	14.1%
Food Chains + Webs	53.8%	64.8%	23.8%
Energy Pyramid	40.6%	50.0%	15.8%
Communities + Ecosystems	49.3%	55.0%	11.2%
Succession	58.4%	61.0%	6.3%

Appendix Table 14

Percent Possible Gain Calculations, Unit II

Concept	Percent Correct Pretest	Percent Correct Posttest	Percent Possible Gain
Thermodynamics -First Law	40.3%	45.6%	8.9%
Burning and Respiration	40.8%	47.3%	10.9%
Energy Requirements -Activity	63.2%	68.3%	13.8%
Energy - Calories	29.4%	34.8%	7.7%
Enzyme Control	53.6%	58.9%	11.4%
Cells	46.8%	57.8%	20.7%
Diffusion	42.6%	56.2%	23.7%
Digestion	29.7%	48.3%	26.4%
Glucose -Photosynthesis	29.4%	45.5%	22.8%
Structure of Compounds	29.6%	35.5%	8.4%
Glucose - Energy	46.4%	41.7%	-8.8%
Energy - ATP	18.8%	29.6%	13.2%
Life Functions	25.0%	31.4%	8.6%
Data Interpretation	29.1%	31.6%	3.5%

Appendix Table 15

Percent Possible Gain Calculations, Unit III

Concept	Percent Correct Pretest	Percent Correct Posttest	Percent Possible Gain
Life from Pre-Existing Life	39.2%	44.3%	8.4%
Reproduction Insures Continuation	68.6%	65.8%	-2.8%
Variation	31.6%	43.0%	16.7%
Fusion	58.5%	73.8%	36.9%
Development	44.1%	51.2%	12.7%
Growth	72.7%	81.3%	31.5%
Flowering Plants	63.0%	70.9%	21.4%
Environmental Conditions	58.2%	62.2%	9.6%
Differentiation	30.4%	36.7%	9.1%
Mitosis	39.5%	50.2%	17.7%
Reproduction, Development, Interplay	47.9%	60.3%	23.8%

Appendix Table 16

Percent Possible Gain Calculations, Unit IV

Concept	Percent Correct Pretest	Percent Correct Posttest	Percent Possible Gain
Inherited Traits-Environment			
A	39.7%	46.2%	10.8%
B	69.1%	77.7%	27.8%
C	55.6%	62.9%	16.5%
Probability			
A	28.9%	35.2%	8.8%
B	40.4%	46.8%	10.8%
Meiosis			
A	29.9%	39.6%	13.8%
B	51.1%	54.0%	6.1%
C	18.4%	37.8%	23.7%
Patterns of Inheritance			
A	45.7%	58.8%	24.1%
B	35.3%	56.7%	33.1%
C	22.1%	33.7%	15.0%
D	23.1%	36.1%	17.0%
E	46.4%	57.6%	20.9%
F	35.4%	44.9%	14.7%
G	25.4%	32.3%	9.3%
H	60.4%	67.2%	17.2%
Genes - Chromosomes			
A	50.6%	55.6%	10.1%
DNA			
A	32.6%	50.1%	26.0%
B	20.9%	49.9%	36.7%
C	23.7%	43.7%	26.2%
D	57.1%	64.3%	17.0%

APPENDIX D

FACTOR ANALYSIS RESULTS

Appendix Table 17

Factor Analysis Results - Unit I, Posttest A

Factor	Items Loading Strongly	Items Loading Weakly
1	13, 15, 20, 24	2, 12
2	11, 17	
3	6, 7	
4	2, 22	21
5	4, 5, 21	
6	16	12, 24
7	18	
8	10, 23	
9	14	
10	1, 19	
11	9, 15	3, 12

Appendix Table 18

Factor Analysis Results - Unit I, Posttest B

Factor	Items Loading Strongly	Items Loading Weakly
1	6, 7	
2	20, 21	
3	9, 14, 15	
4	3, 12	
5	24	
6	1, 2	
7	8, 13, 22	
8	16	5
9	17	
10	18, 23	13
11	10	
12	4, 19	

Appendix Table 19

Factor Analysis Results - Unit II, Posttest A

Factor	Items Loading Strongly	Items Loading Weakly
1	1, 19	
2	10, 11	
3	7, 8	
4	5, 13	14, 27
5	23, 25	
6	24	
7	28, 29	15
8	17, 18	
9	12	
10	16	
11	5, 6	
12	2, 28, 30	
13	9	
14	26	
15	20	
16	3, 4	

Appendix Table 20

Factor Analysis Results - Unit II, Posttest B

Factor	Items Loading Strongly	Items Loading Weakly
1	22, 23, 24	
2	27, 29	
3	6, 7	
4	14	13, 15
5	10, 15	
6	1, 5	
7	9	
8	19, 20	4
9	11, 17, 26	
10	18, 25	
11	12	
12	8	13
13	2	3, 4
14	16	

Appendix Table 21

Factor Analysis Results - Unit III, Posttest A

Factor	Items Loading Strongly	Items Loading Weakly
1	24, 25	
2	17, 18	
3	11, 12	
4	6, 9	23
5	13, 20, 22	
6	30	
7	7, 16, 29	
8	10	
9	27	
10	19	
11	15, 25	8
12	26	7
13	5	
14	1	
15	3	11
16	2, 21, 28	
17	4, 29	14

Appendix Table 22

Factor Analysis Results - Unit III, Posttest B

Factor	Items Loading Strongly	Items Loading Weakly
1	24, 25	
2	17, 18	
3	11, 12	
4	6, 9	23
5	13, 20, 22	
6	30	
7	7, 16, 29	
8	10	
9	27	
10	19	
11	15, 25	8
12	26	7
13	5	
14	1	
15	3	11
16	2, 21, 28	
17	4, 29	14

Appendix Table 23

Factor Analysis Results - Unit IV, Posttest A

Factor	Items Loading Strongly	Items Loading Weakly
1	14, 24	22
2	9, 10	
3	3, 4, 21	
4	2, 16, 22	15
5	26	1
6	7, 8	
7	2, 16, 12, 19	5
8	13	1
9	18	
10	11, 12	
11	17, 23	
12	15	
13	20, 27	
14	25	10

Appendix Table 24

Factor Analysis Results - Unit IV, Posttest B

Factor	Items Loading Strongly	Items Loading Weakly
1	7, 10, 11, 12	
2	5, 25	
3	4, 11	
4	7, 15	
5	6, 26	11
6	2, 9	18
7	8, 22	
8	1	
9	3, 13	
10	14, 20, 22	
11	3, 12, 19, 23	18

APPENDIX E

MULTIPLE LINEAR REGRESSION ANALYSIS

Multiple Linear Regression Analysis

Results - Unit I

For Unit I, the fourth question to be investigated was, Is there a significant difference in the level of achievement on the Unit I posttests among students in classes using Patterns and Processes having different background variables?

The independent variables used to test question 4 were DAT Verbal, DAT Numerical Ability, DAT Total, DRT Comprehension, DRT Speed, and pretest scores. The dependent variable was the posttest score.

The test statistic used in testing the question is the F-statistic generated for each independent variable in the last step of the multiple stepwise regression:

$$F_{\alpha} (\nu 1, \nu 2) = \left(\frac{\beta_i}{S\beta_i}\right)^2$$

where:

β_i represents the weight of the independent variable (slope of the regression line).

$S\beta_i$ represents the standard error of the weight of that variable.

If the β_i's are small, it means that the predictor variable is not doing any predicting. A large $|\beta_i|$ weight indicates some sort of interrelations (technically, the interdependencies or intercorrelations) among the independent variables as they occur in the subjects, and even some sort of relationship between the predictor variable and the criterion. A large positive value for β_i would indicate that the predictor variable in consideration is an effective predictor of achievement. A negative value, however, indicates the predictor is a poor predictor of achievement.[1]

The results for posttest B are summarized in Appendix Table 25.

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[1] C.Benjamin Meleca, "Multiple Linear Regression Analysis: Results and Discussion II," Bioscience 20 (1969): 26-27.

Appendix Table 25

Results of Multiple Linear Regression Analysis for Posttest B, Unit I.

Independent Variable	β_i	$S\beta_i$	F
DAT Verbal	0.06185	0.17781	0.1210
DAT Total	0.15414	0.10595	2.1165
DRT Comprehension	0.12968	0.18390	0.4973
DRT Speed	0.05468	0.09542	0.3284
Pretest A	0.44375	9.05960	55.4335**

**Significant at the .01 level, $F_{.01\ (1,283)} = 6.63$

The F-value for each independent variable determines the level at which that variable is a significant predictor of a score on the posttest instrument.

The DAT Numerical Aptitude score was not entered into the regression equation due to an insufficient F-level for further computation.

The results for posttest A are summarized in Appendix Table 26.

Appendix Table 26

Results of Multiple Linear Regression Analysis for Posttest A, Unit I.

Independent Variable	β_i	$S\beta_i$	F
DAT Verbal	-0.02132	0.17115	0.0155
DAT Total	0.20975	0.08984	5.4510*
DRT Comprehension	0.42339	0.11057	14.6622**
Pretest B	0.30265	0.06068	24.8744**

**Significant at the .01 level, $F_{.01\ (1,315)} = 6.63$

*Significant at the .05 level, $F_{.05\ (1,315)} = 3.84$

DAT Numerical and DRT Speed scores were not entered into the regression equation due to an insufficient F-level for further computation.

Discussion

The data indicate that DAT Verbal, DAT Numerical, DAT Total, DRT Comprehension, and DRT Speed scores are not significant predictors of success on posttest B, Unit I. Pretest A, however, is a highly significant ($p < .01$) predictor of success on posttest B. This result indicates that prior knowledge of ecology determined, to a large extent, whether or not the students attained a high score on posttest B.

The effect of pretest A accounts for approximately 46 percent of the variance in the regression equation. This figure is determined by the multiple r^2 in Appendix Table 27. The combination of pretest A and the DAT Total scores as independent or predictor variables accounts for approximately 50 percent of the variance in the regression equation. Thus, the addition of a second independent or predictor variable to the pretest score only results in a 4 percent reduction of variance, which is not a significant amount. It can also be seen in Appendix Table 27 that including additional variables as predictors of posttest scores accounts for a negligible amount of additional variance.

Appendix Table 27

Summary Table-Multiple Stepwise Regression Analysis - Unit I, Pretest A - Posttest B.

Step Number	Variable Entered	Multiple r	Multiple r^2	Increase in r^2	F-Value to Remove	No. of Independent Variables Included
1	Pretest A	.6750	.4556	.4556	240.1911	1
2	DAT Total	.7052	.4973	.0417	23.7179	2
3	DRT Comp.	.7094	.5032	.0059	3.4003	3
4	DRT Speed	.7098	.5038	.0006	.3342	4
5	DAT Verbal	.7099	.5040	.0002	.1210	5

It is interesting to speculate concerning the remaining 50 percent of the variance. Undoubtedly, some of this is due to random error in student scores. However, the hypothesis that a portion of the variance is due to the effect of the teacher and the teaching situation is tenable. It is also possible that student variables such as class attendance may account for some the variance. In previous studies, the effect of predictor or independent variables have accounted for as much as 80 percent of the variance, leaving a much smaller allowance attributable to to the effect of the teacher. The results in Appendix Table 27, indicating that for posttest B, Unit I, only 50 percent of the variance is being accounted for by the independent variables, leads one to hypothesize that the teacher effect, when using Patterns and Processes, may be much more important than in a "conventional" classroom. This is a very important question that should be investigated and reported in a subsequent study. In addition, it would have been extremely valuable to monitor the classrooms with videotape. By a careful analysis of videotape, much more valuable information could be gathered concerning the classroom and teacher variables.

The data indicate that DAT Verbal, DAT Numerical, and DRT Speed scores are not significant predictors of success on posttest A, Unit I. Pretest B and DRT Comprehension are highly significant ($p < .01$) predictors of success on posttest A, and the DAT Total score is also a significant ($p < .05$) predictor of success on posttest A. These results indicate that reading comprehension, as measured by the DRT Comprehension score, and general aptitude, as measured by the DAT Total score, together with the pretest B score, are significant predictors of success on posttest A. Although previous knowledge of ecology was an important factor governing success on posttest A, the students' general aptitude and reading comprehension were also important factors in determining the level of achievement on posttest A. This was not the case with posttest B.

These results should emphasize the importance of carefully constructed evaluation instruments. Although both posttest forms were testing the same concepts, different skills were apparently utilized in determining the level of achievement on the two alternate forms.

As in posttest B, the independent variables account for only 50 percent of the variance in the regression equation. This result increases the probability of the hypothesis that part of this unaccounted for variance is due to the effect of the teacher and the teaching situation. This result also emphasizes the importance of monitoring classroom activities to gather additional data. Also, as in posttest A, student variables such as class attendance may account for some of this variance.

The effect of pretest B accounts for approximately 41 percent of the variance from the regression equation. In this case, however, the addition of the DAT Total as a concommitant independent variable with pretest B increases the amount of variance accounted for to 50 percent. Little advantage is gained by adding additional independent variables, since the amount of variance accounted for does not increase beyond 50 percent. These figures are obtained from the multiple r^2 values in Appendix Table 28.

Appendix Table 28

Summary Table-Multiple Stepwise Regression Analysis - Unit II, Pretest B - Posttest A.

Step Number	Variable Entered	Multiple r	Multiple r^2	Increase in r^2	F-Value to Remove	No. of Independent Variables Included
1	Pretest B	.6378	.4068	.4068	218.0609	1
2	DRT Comp.	.6843	.4683	.0615	36.6679	2
3	DAT Total	.7007	.4909	.0226	14.0529	3
4	DAT Verbal	.7007	.4910	.0000	.0155	4

Appendix Tables 29 and 30 contain the correlation coefficients (r) between the dependent and all of the independent variables for the Unit I posttests.

Appendix Table 29

Results of Multiple Stepwise Regression Analysis - Correlation Between Independent and Dependent Variables - Unit I, Pretest A-Posttest B.

	DAT Num.	DAT Tot.	DRT Comp.	DRT Speed	Pretest A	Posttest B
DAT Verb.	.697	.929	.709	.743	.655	.588
DAT Num.		.912	.573	.639	.617	.541
DAT Tot.			.700	.753	.691	.614
DRT Comp.				.890	.624	.550
DRT Speed					.631	.563
Pretest A						.675

Appendix Table 30

Results of Multiple Stepwise Regression Analysis - Correlation Between Independent and Dependent Variables - Unit I, Pretest B-Posttest A.

	DAT Num.	DAT Tot.	DRT Comp.	DRT Speed	Pretest B	Posttest A
DAT Verb.	.697	.927	.741	.772	.739	.624
DAT Num.		.915	.539	.604	.593	.532
DAT Tot.			.699	.750	.725	.629
DRT Comp.				.906	.956	.606
DRT Speed					.657	.596
Pretest B						.638

Results - Unit II

For Unit II, the fourth question to be tested was, Is there a significant difference in the level of achievement on the Unit II posttests among students in classes using Patterns and Processes having different background variables?

The independent variables used to test question 4 were DAT Verbal, DAT Numerical Aptitude, DAT Total, DRT Comprehension, DRT Speed, and pretest scores. The dependent variable was the posttest score.

The results for posttest B are summarized in Appendix Table 31.

Appendix Table 31

Results of Multiple Linear Regression Analysis for Posttest B, Unit II.

Independent Variable	β_i	$S\beta_i$	F
DAT Verbal	-0.0935	0.2534	0.1363
DAT Total	0.4904	0.1346	13.2748**
DRT Comp.	0.6287	0.2353	7.1398**
DRT Speed	-0.0919	0.1202	0.5845
Pretest A	0.0801	0.0836	0.9172

**Significant at the .01 level, $F_{.01\ (1,253)} = 6.63$

The F-value for each independent variable determines the level at which that variable is a significant predictor of a score on the posttest instrument.

The DAT Numerical Aptitude score was not entered into the regression equation due to an insufficient F-level for further computation.

The results for posttest A are summarized in Appendix Table 32.

Appendix Table 32

Results of Multiple Linear Regression Analysis for Posttest A, Unit II.

Independent Variable	βi	$S\beta i$	F
DAT Verbal	0.5841	0.1549	14.2274**
DAT Speed	0.2705	0.0899	9.0600**
Pretest B	0.2208	0.0778	8.0505**
DAT Num.	0.0822	0.0642	1.6376

**Significant at the .01 level, $F_{.01\ (1,240)} = 6.63$

DAT Total and DRT Comprehension scores were not entered into the regression equation due to an insufficient F-level for further computation.

Discussion

The data indicate that DAT Verbal, DAT Numerical Aptitude, DRT Speed, and pretest A scores are not significant predictors of success on posttest B, Unit II. DAT Total and DRT Comprehension scores, however, are both highly significant ($p < .01$) predictors of success on posttest B. This result indicates that a combination of general aptitude, as measured by the DAT Total score, and reading comprehension, as measured by the DRT Comprehension score, was the major predictor of success on posttest B.

The effect of the DAT Total score accounts for 36 percent of the variance in the regression equation, as indicated by the multiple r^2 in Appendix Table 33. The combination of DAT Total and DRT Comprehension scores as predictor variables accounts for 39 percent of the variance in the regression equation. It is evident in Appendix Table 33 that the addition of more preditor variables into the regression equation accounts for a negligible amount of additional variance.

Appendix Table 33

Summary Table-Multiple Stepwise Regression Analysis - Unit II, Pretest A - Posttest B.

Step Number	Variable Entered	Multiple r	 r^2	Increase in r^2	F-Value to Remove	No. of Independent Variables Included
1	DAT Total	.5980	.3576	.3576	143.0420	1
2	DRT Comp.	.6211	.3858	.0283	11.7770	2
3	Pretest A	.6230	.3881	.0023	.9659	3
4	DRT Speed	.6242	.3896	.0015	.6196	4
5	DAT Verbal	.6245	.3900	.0003	.1363	5

The combination of five independent variables accounts for 39 percent of the variance. The remaining 61 percent is unaccounted for, and this amount is 11 percent more than the unaccounted for variance in Unit I. This result indicates that the effect of the teacher may account for more variance in Unit II than in Unit I, and reemphasizes the need to investigate teacher effect in subsequent studies of Patterns and Processes. The monitoring of the teaching situations with videotape would have yielded additional valuable information. As in Unit I, some of this unaccounted for variance may be attributable to student variables such as class attendance.

The data indicate that DAT Numerical, DAT Total, and DRT Comprehension scores are not significant preditors of success on posttest A, Unit II. DAT Verbal, DRT Speed, and pretest B scores are all highly significant $(p < .01)$ preditors of success on posttest A. These results indicate that verbal ability, as measured by DAT Verbal scores; reading speed, as measured by DRT Speed scores; and previous knowledge, as measured by pretest B are significant predictors of success on posttest A. Again, the different results obtained with the alternate forms of the posttest emphasize the importance of carefully constructed evaluation instruments. Although both posttest forms were testing the same concepts, different skills were apparently utilized in determining the level of achievement on the two alternate forms.

Concerning the total amount of variance accounted for by the independent variables, the results from posttest A are almost identical with those of posttest B. As indicated in Appendix Table 34, the effect of DAT Verbal scores accounted for 34 percent of the variance in the regression equation. The addition of DRT Speed and pretest B scores accounted for an additional 3 and 2 percent increase, respectively, in the total amount of variance accounted for. The combination of DAT Verbal, DRT Speed, pretest B, and DAT Numerical scores account for a total of 40 percent of the variance in the regression equation.

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Appendix Table 34

Summary Table-Multiple Stepwise Regression Analysis - Unit II, Pretest B - Posttest A.

Step Number	Variable Entered	Multiple r	r^2	Increase in r^2	F-Value to Remove	No. of Independent Variables Included
1	DAT Verbal	.5864	.3439	.3439	127.894	1
2	DRT Speed	.6145	.3776	.0337	73.708	2
3	Pretest B	.6306	.3977	.0201	53.248	3
4	DAT Num.	.6338	.4017	.0040	40.450	4

Appendix Tables 35 and 36 contain the correlation coefficients (r) between the dependent and all of the independent variables for the Unit II posttest.

Appendix Table 35

Results of Multiple Stepwise Regression Analysis - Correlation Between Independent and Dependent Variables - Unit II, Pretest A-Posttest B.

	DAT Num.	DAT Tot.	DRT Comp.	DRT Speed	Pretest A	Posttest B
DAT Verb.	.706	.926	.715	.747	.529	.568
DAT Num.		.922	.531	.599	.455	.537
DAT Tot.			.676	.730	.533	.596
DRT Comp.				.877	.488	.528
Pretest A						.388

Appendix Table 36

Results of Multiple Stepwise Regression Analysis - Correlation Between Independent and Dependent Variables - Unit II, Pretest B-Posttest A.

	DAT Num.	DAT Tot.	DRT Comp.	DRT Speed	Pretest A	Posttest B
DAT Verb.	.705	.929	.698	.749	.608	.586
DAT Num.		.918	.510	.599	.510	.489
DAT Tot.			.658	.733	.607	.584
DRT Comp.				.900	.531	.532
DRT Speed					.565	.561
Pretest B						.497

Results - Unit III

For Unit III, the fourth question to be tested was, Is there a significant difference in the level of achievement on the Unit III posttests among students in classes using Patterns and Processes having different background variables?

The independent variables used to test question 4 were DAT Verbal, DAT Numerical Aptitutde, DAT Total, DRT Comprehension, DRT Speed, and pretest scores. The dependent variable was the posttest score.

The results for posttest B are summarized in Appendix Table 37.

Appendix Table 37

Results of Multiple Linear Regression Analysis for Posttest B, Unit III.

Independent Variable	β_i	$S\beta_i$	F
DAT Verbal	0.0479	0.2872	0.0278
DAT Total	0.3288	0.1655	3.9478*
DRT Comp.	0.6456	0.2642	5.9720*
DRT Speed	-0.1802	0.1467	1.5090
Pretest A	0.3365	0.0675	24.8616**

*Significant at the .05 level, $F_{.05\ (1,214)} = 3.84$

**Significant at the .01 level, $F_{.01\ (1,214)} = 6.63$

The DAT Numerical Aptitude score was not entered into the regression equation due to an insufficient F-level for further computation.

The results for posttest A are summarized in Appendix Table 38.

Appendix Table 38

Results of Multiple Linear Regression Analysis for Posttest A, Unit III.

Independent Variable	β_i	$S\beta_i$	F
DAT Num.	-0.0387	0.0673	0.3309
DAT Verbal	0.3455	0.1444	5.7271*
DRT Comp.	0.6059	0.1465	17.1039**
Pretest B	0.3217	0.0617	27.2308**

*Significant at the .05 level, $F_{.05\ (1,215)} = 3.84$

**Significant at the .01 level, $F_{.01\ (1,215)} = 6.63$

The DAT Total and DRT Speed scores were not entered into the regression equations due to an insufficient F-level for further computation.

Discussion

The data indicate that DAT Verbal, DAT Numerical Aptitude, and DRT Speed scores are not significant predictors of success on posttest B, Unit III. The pretest A scores, however, are highly significant ($p < .01$) and the DAT Total and DRT Comprehension scores are both significant ($p < .05$) predictors. This result indicates that DAT Total, DRT Comprehension, and pretest A scores were the major predictors of success in posttest B.

The effect of the pretest A score accounts for only 22 percent of the variance in the regression equation, as indicated by the multiple r^2 in Appendix Table 39. The combination of pretest A, DAT Total, and DRT Comprehension scores accounts for 32 percent of the variance in the regression equation. The addition of DRT Speed and DAT Verbal scores do not account for a significantly greater amount of the variance.

Appendix Table 39

Summary Table-Multiple Stepwise Regression Analysis - Unit III, Pretest A - Posttest B.

Step Number	Variable Entered	Multiple r	Multiple r^2	Increase in r^2	F-Value to Remove	No. of Independent Variables Included
1	Pretest A	.4669	.2180	.2180	60.7656	1
2	DAT Total	.5442	.2962	.0782	24.1106	2
3	DRT Comp.	.5624	.3163	.0201	6.3489	3
4	DRT Speed	.5666	.3210	.0047	1.4995	4
5	DAT Verbal	.5667	.3211	.0001	.0278	5

With only 32 percent of the variance accounted for by the effect of the independent variables, 68 percent remains unaccounted for. This result indicates that the effect of the teacher may be greater in Unit III than in Units I and II. The need for further investigation into the problem of teacher effect with Patterns and Processes is reemphasized with these results as is the need for carefully planned classroom monitoring with videotape. Again, some of this unaccounted for variance may be attributable to student variables such as class attendance.

The data indicate that DAT Numerical Aptitude, DAT Total, and DRT Speed scores are not significant predictors of success on posttest A, Unit III. Pretest B and DRT Comprehension scores are highly significant ($p < .01$) predictors of success on posttest A, and the DAT Verbal score is also a significant ($p < .05$) predictor. These results indicate that previous knowledge, as measured by pretest B; reading comprehension, as measured by the DRT Comprehension test; and verbal ability, as measured by the DAT Verbal Ability test are significant predictors of success on posttest A. Although previous knowledge of the principles of reproduction and development was an important factor governing success on posttest A, the students reading comprehension was also an important determining factor. The similar results obtained with the alternate forms of the Unit III instruments indicate that, in general, the same skills and abilities were utilized in determing the level of achievement of the two alternate forms. This was not the case with the instruments in the previous 2 units.

For posttest A, the combined independent variables account for 39 percent of the variance in the regression equation, 7 percent more than in posttest B. The DRT Comprehension score accounts for 28 percent of the variance, and when pretest B and DAT Verbal scores are added to the regression equation, an additional 10 and 2 percent gain, respectively, is obtained. The additon of the DAT Numerical score accounts for an extremely small gain in variance. These results are summarized in Appendix Table 40.

Appendix Table 40

Summary Table-Multiple Stepwise Regression Analysis - Unit III, Pretest B - Posttest A.

Step Number	Variable Entered	Multiple r	r^2	Increase in r^2	F-Value to Remove	No. of Independent Variables Included
1	DRT Comp.	.5266	.2773	.2773	85.957	1
2	Pretest B	.6104	.3726	.0953	66.209	2
3	DAT Verbal	.6232	.3884	.0158	46.984	3
4	DAT Num.	.6239	.3893	.0009	35.214	4

Appendix Tables 41 and 42 contain the correlation coefficients (r) between the dependent and all of the independent variables.

Appendix Table 41

Results of Multiple Stepwise Regression Analysis - Correlation Between Independent and Dependent Variables - Unit III, Pretest A - Posttest B.

	DAT Num.	DAT Tot.	DRT Comp.	DRT Speed	Pretest A	Posttest B
DAT Verb.	.503	.878	.566	.575	.404	.430
DAT Num.		.855	.284	.325	.318	.346
DAT Tot.			.496	.525	.418	.449
DRT Comp.				.854	.358	.395
DRT Speed					.398	.355
Pretest A						.467

Appendix Table 42

Results of Multiple Stepwise Regression Analysis - Correlation Between Independent and Dependent Variables - Unit III, Pretest B - Posttest A.

	DAT Num.	DAT Tot.	DRT Comp.	DRT Speed	Pretest B	Posttest A
DAT Verb.	.545	.880	.595	.589	.433	.466
DAT Num.		.878	.373	.362	.198	.230
DAT Tot.			.551	.542	.360	.397
DRT Comp.				.845	.469	.527
DRT Speed					.364	.455
Pretest B						.520

Results - Unit IV

For Unit IV, the fourth question to be tested was, Is there a significant difference in the level of achievement on the Unit IV posttests among students in classes using Patterns and Processes having different background variables?

The independent variables used to test question 4 were DAT Verbal, DAT Numerical Aptitude, DAT Total, DRT Comprehension, DRT Speed, and pretest scores. The dependent variable was the posttest score.

The results for posttest B are summarized in Appendix Table 43.

Appendix Table 43

Results of Multiple Linear Regression Analysis for Posttest B, Unit IV.

Independent Variables	β_i	$S\beta_i$	F
DAT Verbal	0.5833	0.4503	1.6779
DAT Num.	0.3761	0.4634	0.6588
DAT Total	-0.2392	0.4309	0.3082
DRT Comp.	0.8757	0.2660	10.8360**
DRT Speed	-0.1348	0.1379	0.9557
Pretest A	0.1053	0.0818	1.6600

**Significant at the .01 level, $F_{.01\ (1,181)} = 6.63$

The results for posttest A are summarized in Appendix Table 44.

Appendix Table 44

Results of Multiple Linear Regression Analysis for Posttest A, Unit IV.

Independent Variables	β_i	$S\beta_i$	F
DAT Num.	0.0334	0.2588	0.0166
DAT Total	0.4373	0.1647	7.0519**
DRT Comp.	0.2166	0.2511	0.7445
DRT Speed	-0.0268	0.1367	0.0384
Pretest B	0.2447	0.0916	7.1407**

**Significant at the .01 level, $F_{.01\ (1,206)} = 6.63$

The DAT Verbal score was not entered into the regression equation due to an insufficient F-level for further computation.

Discussion

The data indicate that DAT Verbal, DAT Numerical Aptitude, DAT Total, DRT Speed, and pretest A scores are not significant predictors of success on posttest B, Unit IV. DRT Comprehension, however, is a highly significant ($p < .01$) predictor of success on posttest B.

The effect of DRT Comprehension accounts for approximately 24 percent of the variance in the regression equation, as indicated by multiple r^2 in Appendix Table 45. The inclusion of the DAT Verbal scores only account for an additional 2 percent of variance, and the combination of all of the independent variables only account for 28 percent of the variance in the regression equation.

Appendix Table 45

Summary Table-Multiple Stepwise Regression Analysis - Unit IV, Pretest A - Posttest B.

Step Number	Variable Entered	Multiple r	r^2	Increase in r^2	F-Value to Remove	No. of Independent Variables Included
1	DRT Comp.	.4918	.2419	.2419	59.6734	1
2	DAT Verbal	.5120	.2621	.0202	5.0907	2
3	Pretest A	.5202	.2706	.0085	2.1474	3
4	DRT Speed	.5238	.2744	.0038	.9646	4
5	DAT Num.	.5267	.2775	.0031	.7799	5
6	DAT Total	.5279	.2787	.0012	.3082	6

In referring to Appendix Table 43, DAT Total shows a β- weight of -0.2392, indicating that is is not a good predictor of achievement on posttest B. However, DAT Total correlates highly (.539)[1] with DRT Comprehension and much less (.377) with the dependent variable. Since DRT Comprehension scores are good predictors of success on posttest B, it should be noted that the correlation between DAT Total and DRT Comprehension is due to variance not used in predicting the posttest B score. DAT Total is, therefore, a suppressor variable removing unwanted variance from the regression analysis.

For posttest B, 72 percent of the variance in the regression equation remains unaccounted for, indicating that the amount of variance attributable to the teacher is probably much greater than in the previous units. To get a true picture of what has been happening during the year, the teacher effect needs to be investigated. Videotaping is considered to be an indispensable evaluative devise that should accompany any future investigation of Patterns and Processes.

The data indicate that DAT Verbal, DAT Numerical Aptitude, DRT Comprehension, and DRT Speed scores are not significant predictors of success on posttest A, Unit IV. Pretest B and DAT Total scores are highly significant ($p < .01$) predictors of success on posttest A. These results indicate that previous knowledge of the principles of genetics, as measured by pretest B, and general aptitude, as measured by the DAT Total score, are significant predictors of success on posttest A. Although both posttest forms are measuring the same concepts, different predictors are influencing success on each of the forms. These results should again reemphasize the importance of carefully constructed evaluation instruments.

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[1] See Appendix Table 47.

The effect of the DAT Total score accounts for approximately 26 percent of the variance in the regression equation, as indicated by multiple r^2 in Appendix Table 46. The inclusion of the pretest B scores accounts for an additional 3 percent of the variance. The combination of all of the independent variables, excluding DAT Verbal which was not entered, accounts for 29 percent of the variance in the regression equation. This leaves 71 percent of the variance unaccounted for.

Appendix Table 46

Summary Table-Multiple Stepwise Regression Analysis - Unit IV, Pretest B - Posttest A.

Step Number	Variable Entered	Multiple r	Multiple r^2	Increase in r^2	F-Value to Remove	No. of Independent Variables Included
1	DAT Total	.5078	.2578	.2578	75.2982	1
2	Pretest B	.5359	.2872	.0294	8.6536	2
3	DRT Comp.	.5403	.2919	.0047	1.3971	3
4	DRT Speed	.5404	.2921	.0001	.0395	4
5	DAT Num.	.5405	.2921	.0001	.0166	5

In surveying the amount of variance attributable to the effects of the independent variables in all four units, an interesting pattern emerges. In Unit I, 49 to 50 percent of the variance was accounted for. This amount decreased steadily in each succeeding unit until only 28 to 29 percent of the variance was accounted for in Unit IV. If the hypothesis that some of this unaccounted-for variance is attributable to teacher effect, then it would appear that the effect of the teacher increases steadily throughout the year, when using Patterns and Processes. This problem should be investigated further.

Appendix Tables 47 and 48 contain the correlation coefficients (r) between the dependent variable and all of the independent variables for the Unit IV posttests.

Appendix Table 47

Results of Multiple Stepwise Regression Analysis - Correlation Between Independent and Dependent Variables - Unit IV, Pretest A - Posttest B.

	DAT Num.	DAT Tot.	DRT Comp.	DRT Speed	Pretest A	Posttest B
DAT Verb.	.442	.823	.617	.617	.301	.415
DAT Num.		.846	.321	.314	.152	.252
DAT Tot.			.539	.536	.260	.377
DRT Comp.				.868	.397	.492
DRT Speed					.282	.405
Pretest A						.290

Appendix Table 48

Results of Multiple Stepwise Regression Analysis - Correlation Between Independent and Dependent Variables, Unit IV, Pretest B - Posttest A.

	DAT Num.	DAT Tot.	DRT Comp.	DRT Speed	Pretest B	Posttest A
DAT Verb.	.533	.877	.533	.548	.458	.454
DAT Num.		.874	.370	.407	.386	.434
DAT Tot.			.516	.546	.483	.508
DRT Comp.				.866	.385	.347
DRT Speed					.434	.350
Pretest B						.395

APPENDIX F

RESIDUAL GAIN RESULTS

Residual Gain Calculation

In a pretest-posttest design, the residual gain calculation eliminates the effect of regression toward the posttest means. Residual gain is defined as the difference between a predicted score ($Y' = a+bX$) and actual scores on the posttest (Y) or $Y-Y'$, where:

Y' = predicted score.

a = Y intercept of the regression line.

b = slope of the regression line (the pooled regression coefficient was used in this calculation).

X = actual pretest score.

Y = actual posttest score.

Appendix Table 49

Residual Gain - Class Data, Unit I, Pretest A - Posttest B.

Class	N	Mean	Standard Deviation	Standard Error	Maximum	Minimum	Range
1021	12	- 7.0112	13.5117	3.9005	25.4425	-23.7493	49.1918
1032	14	- 2.0960	10.0156	2.6768	12.6753	-23.4065	36.0818
1092	8	2.0573	8.6100	3.0441	17.3607	- 7.4883	24.8491
1111	8	4.5384	8.0611	2.8500	19.0589	- 8.0920	27.1509
1131	6	7.6262	8.5485	3.4899	20.6753	- 1.5370	22.2123
1141	6	2.9907	6.0456	2.4681	9.3607	- 4.1738	13.5346
1142	3	4.1092	4.8264	2.7865	8.6753	- .9411	9.6164
1143	7	5.4192	10.0915	3.8142	15.7444	- 8.9411	24.6855
1144	4	- 9.9034	6.2852	3.1426	- 2.3247	-16.1738	13.8491
1145	5	- 2.7764	10.1512	4.5398	13.3607	-14.6393	28.0000
1153	8	8.4410	9.0930	3.2149	25.4425	- 4.1738	29.6164
1161	5	- .9575	9.1806	4.1057	12.5935	- 9.8720	22.4654
1163	6	9.1310	11.8032	4.8186	25.9566	- 4.1738	30.1305
1164	9	1.7895	11.0621	3.6874	22.2098	-14.3247	36.5346
1165	9	1.4624	6.5211	2.1737	11.8262	- 5.7902	17.6164
1171	8	- 1.4187	7.5824	2.6808	8.2507	-16.1738	24.4245

Appendix Table 49 (continued)

Class	N	Mean	Standard Deviation	Standard Error	Maximum	Minimum	Range
1181	8	4.0078	8.7800	3.1042	16.6753	- 8.3374	25.0127
1201	3	-12.4568	11.4704	6.6225	.5935	-20.9411	21.5346
1221	9	- 2.4554	10.0326	3.3442	11.8262	-18.5575	30.3836
1222	8	.1181	9.9975	3.5347	16.6753	-15.7902	32.4654
1231	18	- 4.1434	16.7432	3.9464	27.8262	-39.3247	67.1509
1241	9	- 3.0408	10.3553	3.4518	18.9771	-20.0920	39.0691
1251	7	2.5120	16.5383	6.2509	34.9771	-15.3247	50.3018
1271	2	8.1689	18.6561	13.1918	21.3607	- 5.0229	26.3836
1281	6	- 6.2957	13.4198	5.4786	10.1280	-30.0024	40.1305
1291	6	- .5289	7.0494	2.8779	10.1280	-11.3247	21.4528
1292	8	- 6.9187	10.6719	3.7731	11.9158	-21.8720	33.7877
1301	5	- 6.6628	10.5940	4.7378	5.4425	-19.2352	24.6777
1302	3	- 1.7629	12.9277	7.4638	11.9080	-13.7902	25.6982
1303	7	-14.6671	6.4498	2.4378	- 6.4757	-24.9411	18.4654
1321	10	5.5080	8.6083	2.7222	15.9080	- 5.7084	21.6164
1322	11	10.2516	8.8449	2.6668	20.7571	- 6.4757	27.2327

Appendix Table 49 (continued)

Class	N	Mean	Standard Deviation	Standard Error	Maximum	Minimum	Range
1323	10	1.6092	5.7699	1.8246	9.5243	- 8.0920	17.6164
1324	11	5.7410	9.1740	2.7661	15.9080	- 6.4757	22.3836
1325	11	1.0761	10.6771	3.2193	15.0589	-16.8593	31.9182
1341	8	- 1.0494	12.9430	4.5761	19.2303	-17.7902	37.0204
1351	11	- 4.8788	17.0264	5.1336	22.2098	-27.3247	49.5346

Appendix Table 50

Residual Gain - Class Data, Unit I, Pretest B - Posttest A.

Class	N	Mean	Standard Deviation	Standard Error	Maximum	Minimum	Range
1021	11	- 2.5435	7.1049	2.1422	5.4028	-17.7892	23.1920
1032	10	1.6563	13.8010	4.3643	17.8068	-18.5972	36.4040
1092	6	8.3388	15.7003	6.4096	19.2008	-22.1932	41.3940
1111	11	- 3.3543	12.9040	3.8907	13.4028	-28.5417	41.9445
1131	6	- 2.9995	10.9508	4.4707	6.7968	-23.0012	29.7980
1141	5	-11.8012	10.5720	4.7279	4.9988	-23.4052	28.4040
1142	4	.7513	6.3375	3.1688	6.7968	- 6.1932	12.9900
1143	4	5.1553	6.2217	3.1109	14.2108	.0088	14.2020
1144	6	- 8.4625	9.1141	3.7208	3.6048	-20.7992	24.4040
1145	6	7.3051	11.2719	4.6017	18.7968	-12.3952	31.1920
1153	8	2.9577	10.0678	3.5595	16.0088	-11.0012	27.0100
1161	3	- 7.8699	5.4387	3.1400	- 1.6072	-11.4052	9.7980
1163	8	2.8914	9.4894	3.3550	19.6048	-15.0012	34.6060
1164	11	4.4152	9.5969	2.8936	19.2008	-19.0367	38.2375
1165	8	9.1137	7.3350	2.5933	15.4228	- 7.2942	22.7170
1171	12	- 7.7159	11.7481	3.3914	7.6048	-26.3397	33.9445

Appendix Table 50 (continued)

Class	N	Mean	Standard Deviation	Standard Error	Maximum	Minimum	Range
1181	11	3.3146	9.9375	2.9963	17.4028	-18.1932	35.5960
1201	5	2.6583	12.5073	5.5935	15.6048	-18.1932	33.7980
1221	14	- .1225	11.4738	3.0665	17.8068	-19.5872	37.3940
1222	11	.2049	11.6734	3.5197	13.4028	-25.6072	39.0100
1231	18	2.4721	11.8788	2.7999	21.0088	-22.1932	43.2020
1241	7	- 3.3208	11.3524	4.2908	17.1098	-17.6072	34.7170
1251	6	4.0206	6.6974	2.7342	16.8168	- 2.5972	19.4140
1271	3	- 4.2235	7.0982	4.0982	.4128	-12.3952	12.8080
1281	5	- 3.0700	16.8681	7.5436	14.8068	-25.7892	40.5960
1291	7	2.3154	18.8105	7.1097	18.4683	-34.5972	53.0655
1292	2	7.4028	11.0280	7.7980	15.2008	- .3952	15.5960
1301	9	- 6.8172	11.3950	3.7983	5.4028	-32.7992	38.2020
1302	10	- 7.9815	8.2865	2.6204	4.9988	-20.2487	25.2475
1303	9	- 9.7285	13.3865	4.4622	10.3928	-31.9912	42.3840
1321	15	1.4339	8.0596	2.0810	18.7968	-15.0012	33.7980
1322	14	4.1385	8.6486	2.3114	16.9988	-12.2132	29.2120

Appendix Table 50 (continued)

Class	N	Mean	Standard Deviation	Standard Error	Maximum	Minimum	Range
1323	13	1.0999	8.0926	2.2445	12.9988	-15.8092	28.8080
1324	13	3.4542	10.5776	2.9337	16.1908	-20.7992	36.9900
1325	13	3.5334	7.8893	2.1881	16.5948	-10.0112	26.6060
1341	4	- 1.6982	13.0250	6.5125	15.6048	-14.5972	30.2020
1351	12	- 7.0501	15.0361	4.3405	19.6148	-24.3397	43.9545

Appendix Table 51

Residual Gain - Class Data, Unit II, Pretest A - Posttest B.

Class	N	Mean	Standard Deviation	Standard Error	Maximum	Minimum	Range
1021	13	- 7.1857	10.9768	3.0444	11.3818	-25.4853	36.8671
1032	15	- 7.1696	11.2061	2.3934	9.2322	-23.8426	33.0748
1052	6	- 3.4243	13.0403	5.3237	13.2932	-22.7983	36.0916
1072	3	-11.0467	7.6130	4.3954	- 3.0670	-18.2304	15.1634
1081	3	1.2322	6.2685	3.6191	5.2322	- 5.9922	11.2244
1092	3	2.3070	32.1702	18.5735	25.2322	-34.4686	59.7008
1131	8	- 9.3166	8.5939	3.0384	- .1418	-24.9174	24.7756
1141	6	- 5.4742	18.5340	7.5665	19.3818	-35.5434	54.9252
1143	5	-13.2276	18.8838	8.4451	15.0826	-28.9174	44.0000
1144	5	- 4.3168	17.6102	7.8755	17.5314	-20.9922	38.5236
1145	4	-13.9769	19.4398	9.7199	1.1712	-42.4686	43.6398
1152	9	- 3.6514	15.8727	5.2909	14.3070	-35.5434	49.8504
1153	6	5.0928	16.4827	6.7290	22.0078	-17.1556	39.1634
1154	10	7.5350	8.0404	2.5426	17.2322	- 5.4686	22.7008
1171	9	- 5.1593	19.0864	6.3621	28.1574	-30.4686	58.6260
1181	11	- 8.1191	10.9033	3.2875	10.3070	-28.0808	38.3878

Appendix Table 51 (continued)

Class	N	Mean	Standard Deviation	Standard Error	Maximum	Minimum	Range
1192	4	-10.9132	13.7421	6.8711	2.0078	-27.1113	29.1191
1201	7	- 7.2130	10.7832	4.0757	1.5314	-28.9312	30.4626
1221	10	9.9325	12.1524	3.8429	32.4566	- 4.6182	37.0748
1222	10	- .6304	10.3680	3.2786	13.2322	-19.3052	32.5374
1231	18	- 2.5183	13.2481	3.1226	11.3818	-35.0670	46.4488
1241	7	6.0553	14.2382	5.3816	29.8306	-12.9174	42.7480
1251	7	- 9.9296	13.6153	5.1461	10.6062	-28.9174	39.5236
1301	6	- 3.0263	15.6867	6.4041	18.6062	-20.9174	39.5236
1302	8	- 5.8235	15.5929	5.5129	15.3818	-28.3495	43.7313
1303	6	- 3.8029	13.5356	5.5259	10.7834	-24.9174	35.7008
1321	13	12.7755	19.7713	5.4836	43.0826	-20.9174	64.0000
1322	13	23.2616	12.0328	3.3373	38.0078	3.0826	34.9252
1323	13	5.0606	15.8973	4.4091	31.8582	-20.4410	52.2992
1324	11	24.2100	13.3022	4.0108	37.2322	- 3.0670	40.2992
1351	11	- 8.0715	14.3556	4.3284	17.2322	-27.5739	44.8061

Appendix Table 52

Residual Gain - Class Data, Unit II, Pretest B - Posttest A.

Class	N	Mean	Standard Deviation	Standard Error	Maximum	Minimum	Range
1021	11	4.2219	14.3016	4.3121	23.6428	-29.3995	53.0424
1032	14	- 1.3531	10.8960	2.9121	16.4554	-18.6909	35.1463
1052	6	- 1.6111	19.2710	7.8674	18.9753	-35.6909	54.6662
1072	5	-13.1910	11.2881	5.0482	6.0588	-22.5240	28.5828
1081	6	- 4.4967	9.8010	4.0012	13.6428	-15.7744	29.4172
1092	6	- 7.9132	6.5706	2.6824	4.2256	-15.4406	19.6662
1131	6	- 5.0384	11.8832	4.8513	9.6428	-17.9412	27.5841
1141	5	- 8.1410	11.0364	4.9356	2.3925	-21.9412	24.3338
1143	6	- 8.2605	6.6631	2.7202	2.3925	-15.0247	17.4172
1144	5	- 1.2244	6.0020	2.6842	4.9753	-11.0247	16.0000
1145	6	- 7.9549	11.6947	4.7743	14.0588	-15.7744	29.8331
1152	8	- 4.2691	10.9611	3.8753	12.8097	-19.6486	32.4583
1153	8	- 2.9751	13.6265	4.8711	11.9548	-28.5240	40.4788
1154	5	- 9.2118	14.6622	6.5571	8.2256	-21.2737	29.4994
1171	8	- 8.1622	6.9366	2.4525	1.7879	-16.8578	18.6457
1181	10	- 9.5158	10.3276	3.2659	10.9971	-23.9412	34.9384

Appendix Table 52 (continued)

Class	N	Mean	Standard Deviation	Standard Error	Maximum	Minimum	Range
1192	3	-20.8852	12.6950	7.3295	- 7.1068	-32.1081	25.0013
1201	5	- 5.4160	5.4129	2.4207	2.0588	-12.7949	14.8537
1221	7	- .8785	10.4398	3.9459	15.4760	-17.6075	33.0834
1222	8	11.0799	13.5278	4.7828	31.4760	-12.5240	44.0000
1231	15	1.3047	12.5193	3.2325	23.1422	-19.0247	42.1669
1241	4	- 3.6075	8.6033	4.3017	7.8097	-11.4406	19.2503
1251	6	- 6.5103	14.1402	5.7727	6.3925	-31.7744	38.1669
1301	8	- 7.9331	10.9314	3.8648	11.8919	-23.4406	35.3325
1302	6	- 9.6075	21.1995	8.6547	16.6416	-35.4406	52.0822
1303	7	-17.3100	8.0533	3.0439	- 5.6075	-27.7744	22.1669
1321	15	15.6750	22.2095	5.7345	41.8919	-29.1916	71.0834
1322	13	28.9303	19.9330	5.5284	50.3925	-12.4419	62.8344
1323	8	24.0273	21.0831	7.4540	46.8084	- 7.0247	53.8331
1324	12	14.8814	20.2142	5.8353	44.6416	-13.6075	58.2490
1351	13	-10.4026	7.6037	2.1089	- .1081	-26.3572	26.2490

Appendix Table 53

Residual Gain - Class Data, Unit III, Pretest A - Posttest B.

Class	N	Mean	Standard Deviation	Standard Error	Maximum	Minimum	Range
1021	10	9.0687	11.2963	3.5722	22.3844	-11.5539	33.9383
1032	16	- 3.7150	15.7923	3.9481	28.3638	-27.5128	55.8766
1052	11	5.4104	13.2788	4.0037	27.8278	-19.5951	47.4229
1061	4	16.5004	6.6541	3.3270	24.3638	8.4461	15.9178
1072	4	- 1.1725	13.1754	6.5877	8.4461	-19.4717	27.9178
1081	6	3.3464	8.8863	3.6278	12.2816	- 7.9666	20.2481
1092	8	- 8.8840	10.3058	3.6437	4.6105	-20.4923	25.1028
1101	6	- 6.6107	23.1832	9.4645	19.2919	-47.5539	66.8458
1131	8	3.2192	19.4476	6.8758	32.3638	-25.5334	57.8972
1141	5	- 3.0981	16.0732	7.1882	15.3844	-21.4511	36.8355
1144	4	5.8895	11.3090	5.6545	18.4255	- 5.5334	23.9589
1145	5	3.1345	11.4473	5.1194	14.0951	-15.5128	29.6079
1152	7	- 1.1283	15.6983	5.9334	20.5694	-16.5745	37.1439
1153	8	8.7410	9.4137	3.3282	20.0334	- 5.5334	25.5668
1154	5	- 3.7005	11.9351	5.3375	8.4872	-20.4923	28.9794
1171	8	.1113	14.9236	5.2763	24.4461	-25.7801	50.2262

Appendix Table 53 (continued)

Class	N	Mean	Standard Deviation	Standard Error	Maximum	Minimum	Range
1181	12	- 7.8596	18.0651	5.2150	16.3227	-43.6567	59.9794
1201	5	9.6173	14.0892	6.3009	20.4049	-13.6979	34.1028
1221	8	- .5591	14.6962	5.1959	16.4461	-29.6979	46.1439
1222	8	.2592	18.2167	6.4406	38.3433	-26.0694	64.4126
1231	17	7.5273	10.6741	2.5888	24.4872	- 9.6979	34.1850
1241	6	3.5043	10.5682	4.3144	16.4872	- 9.4100	25.8972
1251	7	2.3605	11.6498	4.4032	17.9306	-12.1310	30.0617
1292	6	1.0853	19.2321	7.8556	26.2610	-21.5745	47.8355
1301	7	- 2.4583	14.4314	5.4546	8.4872	-27.5539	36.0411
1302	6	- 2.8099	11.7499	4.7969	8.5283	-17.6567	26.1850
1303	6	- 1.2309	8.9517	3.6545	8.5283	-15.6362	24.1645
1341	7	-13.9972	14.4755	5.4712	2.5077	-35.6362	38.1439
1351	10	-13.9293	23.5650	7.4519	14.4255	-57.4923	71.9178

Appendix Table 54

Residual Gain - Class Data, Unit III, Pretest B - Posttest A.

Class	N	Mean	Standard Deviation	Standard Error	Maximum	Minimum	Range
1021	14	- 1.0795	12.1511	3.2475	14.4701	-27.6382	42.1084
1032	11	5.2400	18.8407	5.6807	37.9430	-27.9486	65.8916
1052	5	- .4934	5.3355	2.3861	7.9283	- 5.9633	13.8916
1061	8	.0398	11.0404	3.9034	15.7116	-18.0717	33.7833
1072	10	-11.9160	15.9792	5.0531	5.6032	-47.0717	52.6749
1081	6	1.7116	13.8793	5.6662	18.0367	-22.8302	40.8669
1092	7	- 5.2399	11.8392	4.4748	11.4949	-25.2737	36.7686
1101	7	- 7.8240	24.7468	9.3534	14.2534	-58.1800	72.4334
1131	7	8.5926	8.9668	3.3891	20.3618	- 4.5051	24.8669
1141	5	-10.2550	9.1765	4.1039	3.7116	-21.5299	25.2415
1144	5	- 2.0875	14.4441	6.4596	9.8200	-26.0570	35.8769
1145	5	5.0012	10.8782	4.8649	23.7116	- 3.8550	27.5666
1152	9	3.3355	8.9919	2.9973	16.1450	-15.6382	31.7833
1153	7	1.0402	12.4791	4.7167	19.2782	-12.0717	31.3498
1154	9	.8561	6.1411	2.0470	9.6032	- 7.8550	17.4582
1171	10	- .2141	8.2922	2.6222	14.9036	-12.0717	26.9752

Appendix Table 54 (continued)

Class	N	Mean	Standard Deviation	Standard Error	Maximum	Minimum	Range
1181	10	- 2.9958	9.6321	3.0460	8.1450	-17.9633	26.1084
1201	4	4.7201	8.5630	4.2815	14.2534	- 5.9881	20.2415
1221	10	8.6046	11.2826	3.5679	26.2534	- 5.5299	31.7833
1222	10	10.1081	10.9279	3.4557	26.2534	-14.4904	40.7438
1231	15	5.4984	9.2843	2.3972	17.6032	-15.8550	33.4582
1241	6	1.3602	10.6494	4.3476	19.7116	-12.9386	32.6502
1251	7	- 7.5791	26.7644	10.1160	20.3618	-59.2884	79.6502
1292	4	- 1.9091	19.9736	9.9868	20.3618	-24.2884	44.6502
1301	6	- 5.2039	19.5909	7.9980	17.8200	-41.0964	58.9164
1302	7	10.0915	9.6527	3.6484	27.3370	- 2.1800	29.5170
1303	5	- 5.9200	11.0580	4.9453	9.3865	-21.7466	31.1331
1341	4	- 4.3882	8.2887	4.1444	5.3865	-14.8550	20.2415

Appendix Table 55

Residual Gain - Class Data, Unit IV, Pretest A - Posttest B.

Class	N	Mean	Standard Deviation	Standard Error	Maximum	Minimum	Range
1021	7	- 1.4972	15.8901	6.0059	15.5311	-21.4838	37.0149
1032	14	1.0945	12.4641	3.3312	24.3192	-17.9580	42.2772
1052	8	4.3284	10.8530	3.8371	25.8083	- 5.2501	31.0584
1061	7	- 3.7328	8.6338	3.2633	10.2757	-13.9798	24.2554
1072	7	-14.6088	8.6106	3.2545	- 3.4471	-25.1699	21.7228
1141	4	1.3722	9.5485	4.7743	15.0638	- 6.1917	21.2554
1143	5	8.1119	8.8420	3.9543	17.5746	- 1.6590	19.2337
1152	6	1.7413	15.7910	6.4467	20.0855	-17.1699	37.2554
1153	8	- .8085	11.9035	4.2085	16.7866	-22.4254	39.2119
1154	8	- 1.5239	15.9046	5.6231	20.5529	-19.9145	40.4674
1171	6	- 9.6407	13.7030	5.5942	5.5746	-27.6808	33.2554
1181	8	4.2737	11.0428	3.9042	21.5746	-13.1699	34.7446
1201	5	- 5.7830	6.7677	3.0266	.5529	-15.9145	16.4674
1221	12	9.8399	17.0402	4.9191	38.8301	-18.1917	57.0218
1222	5	5.5412	14.4384	6.4570	25.7281	- 7.6808	33.4089
1231	19	3.5005	19.2563	4.4177	38.8301	-24.7026	63.5326

Appendix Table 55 (continued)

Class	N	Mean	Standard Deviation	Standard Error	Maximum	Minimum	Range
1241	5	6.0594	12.9113	5.7741	25.3410	- 5.9580	31.2990
1251	7	5.0314	15.1092	5.7107	29.2608	-14.1917	43.4525
1291	7	- .6109	11.9306	4.5093	20.0855	-13.9580	34.0435
1292	4	-16.4254	12.0046	6.0023	- 2.6590	-28.7026	26.0435
1301	7	8.2713	17.3549	6.5595	40.3192	-15.9145	56.2337
1302	7	- 4.8914	14.6181	5.5251	19.1439	-22.1917	41.3356
1303	6	1.3119	6.1383	2.5059	8.3192	- 7.9145	16.2337
1333	4	-11.9400	4.7897	2.3949	- 7.9145	-18.7392	10.8247
1351	13	- 6.7644	8.0762	2.2399	6.8301	-19.2134	26.0435

Appendix Table 56

Residual Gain - Class Data, Unit IV, Pretest B - Posttest A.

Class	N	Mean	Standard Deviation	Standard Error	Maximum	Minimum	Range
1021	14	5.7822	12.3152	3.2914	22.7951	-21.9410	44.7361
1032	16	7.1387	13.0127	3.2532	26.3784	-10.6771	37.0555
1052	8	1.6767	16.2858	5.7579	29.1307	-28.9410	58.0717
1061	9	2.7840	13.0664	4.3555	23.8506	-13.9734	37.8241
1072	6	-14.8052	12.7193	5.1926	2.0266	-28.8530	30.8796
1141	6	- 9.7867	10.9060	4.4523	5.6747	-24.5012	30.1759
1143	6	4.5173	10.3070	4.2078	14.0266	-12.5012	26.5278
1152	6	- 1.8589	13.0699	5.3358	16.5543	-22.1656	38.7199
1153	6	- 3.5413	15.5783	6.3598	15.1470	-25.2698	40.4167
1154	9	.8321	10.5840	3.5280	14.3784	-20.8530	35.2314
1171	5	- 9.5494	17.1837	7.6848	8.5543	-34.3253	42.8796
1181	11	6.5306	14.5285	4.3805	23.1145	-18.3253	41.4398
1201	5	9.3608	9.1275	4.0819	18.3784	- 4.6933	23.0717
1221	10	- 2.2230	13.9921	4.4247	23.8506	-23.0290	46.8796
1222	12	- 1.0134	10.8050	3.1191	14.0266	-16.1494	30.1759
1231	20	- 4.2593	13.3329	2.9813	16.6192	-28.5012	45.1204

Appendix Table 56 (continued)

Class	N	Mean	Standard Deviation	Standard Error	Maximum	Minimum	Range
1241	10	7.7330	9.3631	2.9609	25.6747	- 8.9734	34.6482
1251	7	.8106	12.7755	4.8287	19.8506	-13.9734	33.8241
1291	4	- 1.3895	21.4261	10.7131	22.0266	-29.6216	51.6482
1292	5	12.2155	16.9279	7.5704	33.3229	-13.6216	46.9445
1301	7	- 8.3597	11.3535	4.2912	15.4988	-19.7975	35.2963
1302	6	6.9348	18.5255	7.5630	26.7951	-23.4132	50.2084
1303	8	- 6.6852	13.4441	4.7532	16.2674	-22.3253	38.5926
1333	5	- 4.6086	12.6830	5.6720	8.2025	-24.1494	32.3518
1351	12	- 7.0560	16.4468	4.7478	18.3784	-28.1494	46.5278

APPENDIX G

SUMMARY TABLES

Appendix Table 57

Summary of Mean Scores by Class for the Dependent and Independent Variables, Unit I, Pretest A - Posttest B.

Class	N	Mean Posttest B	Standard Deviation Posttest B	Adjusted Mean Posttest B	Mean Pretest A	Mean DAT Verbal	Mean DAT Numer.	Mean DAT Total	Mean DRT Comp.	Mean DRT Speed	Mean Res-Gain
1021	12	51.0000	14.2829	52.0061	55.0833	16.3333	11.8333	28.1667	26.7500	51.2500	-7.0112
1032	14	52.9286	12.5175	56.9213	50.0714	16.1429	14.4286	30.5714	24.7857	42.0000	-2.0960
1092	8	59.1250	13.1956	61.0746	53.5000	11.2500	5.8750	17.1250	18.5000	29.1250	2.0573
1111	8	62.5000	11.0970	63.5556	55.0000	11.1250	11.5000	22.6250	17.0000	29.7500	4.5384
1131	6	68.6667	8.9144	66.6435	60.1667	28.3333	18.5000	46.8333	26.1667	37.8333	7.6262
1141	6	54.0000	8.2946	62.0080	43.3333	11.6667	9.5000	21.1667	17.1667	27.0000	2.9907
1142	3	62.6667	8.3267	63.1265	56.0000	18.0000	14.6667	32.6667	23.0000	41.3333	4.1092
1143	7	60.5714	14.5012	64.4364	50.2857	16.5714	8.2857	24.8571	21.0000	29.4286	5.4192
1144	4	49.2500	10.8743	49.1139	57.0000	19.0000	8.5000	27.5000	26.0000	35.5000	-9.9034
1145	5	47.2000	10.3537	56.2409	41.6000	16.0000	11.2000	27.2000	18.4000	37.0000	-2.7764
1153	8	63.1250	12.0646	67.4582	49.5000	16.0000	11.6250	27.6250	18.6250	29.6250	8.4410
1161	5	57.6000	15.3883	58.0598	56.0000	18.2000	14.6000	32.8000	30.4000	45.4000	- .9575
1163	6	66.0000	10.3537	68.1482	53.1667	18.5000	12.1667	30.6667	21.0000	41.8333	9.1310
1164	9	62.3333	14.0357	60.8068	59.3333	15.8889	7.8889	23.7778	23.2222	42.5556	1.7895
1165	9	56.4444	11.2151	60.4797	50.0000	14.3333	9.3333	23.6667	19.8889	36.8889	1.4624
1171	8	55.5000	13.9284	57.5986	53.2500	13.2500	7.7500	21.0000	22.1250	31.3750	-1.4187

Appendix Table 57 (continued)

Class	N	Mean Posttest B	Standard Deviation Posttest B	Adjusted Mean Posttest B	Mean Pretest A	Mean DAT Verbal	Mean DAT Numer.	Mean DAT Total	Mean DRT Comp.	Mean DRT Speed	Mean Res-Gain
1181	8	57.5000	19.1162	63.0250	47.5000	13.2500	8.5000	21.7500	20.5000	37.0000	4.0078
1201	3	41.3333	10.0664	46.5604	48.0000	6.6667	5.3333	12.0000	18.0000	25.0000	-12.4568
1221	9	54.7778	11.3333	56.5618	53.7778	14.8889	9.0000	23.8889	19.6667	31.7778	-2.4554
1222	8	58.7500	12.6914	59.1353	56.1250	13.3750	12.5000	25.8750	20.2500	32.5000	.1181
1231	18	53.2222	19.0249	54.8739	54.0000	16.8333	9.2778	26.1111	19.4444	33.7222	-4.1434
1241	9	59.5556	7.8599	55.9764	62.7778	20.3333	13.6667	34.0000	24.0000	41.4444	-3.0408
1251	7	62.8571	16.2832	61.5292	59.0000	18.8571	13.2857	32.1429	20.7143	38.7143	2.5120
1271	2	56.0000	16.9706	67.1862	38.0000	4.5000	.5000	5.0000	22.0000	36.5000	8.1689
1281	6	41.8333	12.5286	52.7216	38.5000	12.3333	6.0000	18.3333	18.3333	24.6667	-6.2957
1291	6	57.3333	9.3524	58.4884	54.8333	13.5000	10.6667	24.1667	19.3333	34.6667	-.5289
1292	8	50.0000	15.4180	52.0986	53.2500	16.2500	11.0000	27.2500	21.1250	37.2500	-6.9187
1301	5	48.2000	18.7670	52.3544	49.8000	18.0000	14.0000	32.0000	24.6000	43.6000	-6.6628
1302	3	56.0000	21.1660	57.2544	54.6667	22.0000	19.0000	41.0000	18.6667	33.0000	-1.7629
1303	7	44.5714	11.6456	44.3502	57.1429	13.5714	14.2857	27.8571	19.8571	32.4286	-14.6671
1321	10	73.6000	11.9555	64.3502	72.0000	29.6000	24.4000	54.0000	31.2000	59.1000	5.5080
1322	11	80.7273	12.8770	64.5253	76.0000	32.1818	29.0000	61.1818	31.0909	62.7273	10.2516

Appendix Table 57 (continued)

Class	N	Mean Posttest B	Standard Deviation Posttest B	Adjusted Mean Posttest B	Mean Pretest A	Mean DAT Verbal	Mean DAT Numer.	Mean DAT Total	Mean DRT Comp.	Mean DRT Speed	Mean Res-Gain
1323	10	72.8000	6.4773	69.2689	77.2000	33.7000	26.0000	59.7000	32.9000	66.2000	1.6092
1324	11	76.0000	11.7303	60.6266	75.6364	31.8182	29.9091	61.7272	32.4546	64.3636	5.7410
1325	11	69.8182	10.9345	64. 7584	73.0909	31.1818	23.9091	55.0909	33.5454	61.3636	1.0761
1341	8	47.7500	14.4395	60.0934	39.6250	7.7500	4.8750	12.6250	14.6250	26.2500	-1.0494
1351	11	54. 5454	17.1835	57.9678	57.4546	16.7273	16.8182	33.5454	20.3636	36.5454	-4.8788

Appendix Table 58

Summary of Mean Scores by Class for the Dependent and Independent Variables, Unit I, Pretest B - Posttest A.

Class	N	Mean Posttest A	Standard Deviation Posttest A	Adjusted Mean Posttest A	Mean Pretest B	Mean DAT Verbal	Mean DAT Numer.	Mean DAT Total	Mean DRT Comp.	Mean DRT Speed	Mean Res-Gain
1021	11	56.0000	11.3137	60.8846	44.6364	12.0909	11.1818	23.2727	21.0000	39.2727	- 2.5435
1032	10	60.4000	13.2598	65.0844	45.0000	18.4000	12.4000	30.8000	22.7000	44.6000	1.6563
1092	6	68.0000	16.9706	71.7669	46.6667	8.8333	4.6667	13.5000	17.6667	29.5000	8.3388
1111	11	57.0909	13.9818	60.0738	48.0909	12.2727	12.7273	25.0000	19.0909	36.0909	- 3.3543
1131	6	62.1667	11.3564	60.4286	56.6667	23.5000	22.6667	46.1667	18.8333	31.1667	- 2.9995
1141	5	55.2000	9.9599	51.6269	60.0000	15.8000	6.2000	22.0000	22.0000	36.4000	-11.8012
1142	4	65.0000	10.0000	64.1794	55.0000	20.7500	15.7500	36.5000	22.7500	41.2500	0.7513
1143	4	65.0000	6.0000	68.5834	47.0000	15.7500	13.2500	29.0000	22.0000	38.7500	5.1553
1144	6	52.6667	6.8896	54.9656	49.3333	15.5000	8.6667	24.1667	22.5000	35.1667	- 8.4625
1145	5	67.2000	15.5949	70.7332	47.3333	13.8000	10.5000	22.0000	22.0000	36.5000	7.3051
1153	8	67.0000	10.4198	66.3859	54.6250	19.8750	9.1250	29.0000	23.1250	38.8750	2.9577
1161	3	61.3333	10.0665	55.5583	64.0000	17.6667	12.6667	30.3333	24.3333	46.3333	- 7.8699
1163	8	64.2500	10.9642	66.3195	49.7500	15.5000	11.2500	26.7500	21.3750	39.2500	2.8914
1164	11	68.3636	15.3315	67.8433	54.4546	16.4546	12.3636	28.8182	23.0000	36.9091	4.4152
1165	8	73.5000	12.2708	72.5418	55.2500	23.2500	12.7500	36.0000	28.3750	49.8750	9.1137
1171	12	48.0000	14.8691	55.7122	39.5000	9.4167	4.2500	13.6667	15.3333	24.3333	- 7.7159

Appendix Table 58 (continued)

Class	N	Mean Posttest A	Standard Deviation Posttest A	Adjusted Mean Posttest A	Mean Pretest B	Mean DAT Verbal	Mean DAT Numer.	Mean DAT Total	Mean DRT Comp.	Mean DRT Speed	Mean Res-Gain
1181	11	62.9091	12.4053	66.7427	46.5455	9.6364	11.2727	20.9091	15.2727	25.4546	3.3146
1201	5	59.2000	13.0843	66.0864	41.0000	11.4000	9.6000	21.0000	14.6000	21.4000	2.6583
1221	14	58.8571	13.3524	63.3056	45.4286	13.0714	8.5714	21.6429	20.0714	30.2143	- 0.1225
1222	11	65.4546	10.7737	63.6331	56.8182	15.8182	11.7273	27.5455	23.6364	35.5455	0.2049
1231	18	66.7778	13.5106	68.3121	50.7222	16.3333	15.0000	31.3333	21.7778	37.6667	2.4721
1241	7	61.7143	6.0474	60.1073	56.4286	17.8571	13.2857	31.1429	23.1429	34.2857	- 3.3208
1251	6	65.3333	3.2660	67.4487	49.6667	15.6667	13.6667	29.3333	15.3333	26.1667	4.0206
1271	3	50.6667	2.3094	59.2046	38.0000	4.6667	4.0000	8.6667	20.0000	24.3333	- 4.2235
1281	5	51.6000	20.3544	60.3581	37.6000	11.6000	7.2000	18.8000	18.6000	22.6000	- 3.0700
1291	7	58.8571	18.1423	65.7436	41.0000	12.5714	9.8571	22.2857	17.8571	30.0000	2.3154
1292	2	70.0000	14.1421	70.8309	52.0000	18.5000	18.5000	37.0000	24.0000	47.5000	7.4028
1301	9	53.3333	10.9545	56.6109	47.5556	18.2222	15.5556	33.7778	17.0000	30.4444	- 6.8172
1302	10	53.9000	8.0478	55.4466	50.7000	15.4000	12.7000	28.1000	16.7000	27.1000	- 7.9815
1303	9	50.6667	19.6977	53.6996	48.0000	16.4444	16.4444	32.8889	19.4444	32.1111	- 9.7285
1321	15	73.8667	10.1268	64.8620	69.8667	31.0667	26.8667	57.9333	30.7333	56.2000	1.4339
1322	14	78.5714	7.4598	67.5667	73.5000	29.4286	26.0714	55.5000	31.8571	63.4286	4.1385

Appendix Table 58 (continued)

Class	N	Mean Posttest A	Standard Deviation Posttest A	Adjusted Mean Posttest A	Mean Pretest B	Mean DAT Verbal	Mean DAT Numer.	Mean DAT Total	Mean DRT Comp.	Mean DRT Speed	Mean Res-Gain
1323	13	75.3846	7.8053	64.5280	73.2308	30.8462	26.9231	57.7692	31.1539	61.6923	1.0999
1324	13	77.2308	12.6896	66.8823	72.3077	31.6923	27.5385	59.2308	30.3077	59.6923	3.4542
1325	13	74.7692	7.3729	66.9615	67.6923	33.0000	22.7692	55.7692	30.9231	61.4615	3.5334
1341	4	62.0000	16.1658	61.7299	54.0000	17.5000	7.5000	25.0000	24.2500	45.5000	- 1.6982
1351	12	49.5833	21.3007	56.3780	41.1667	11.8333	13.4167	25.2500	16.3333	32.2500	- 7.0501

Appendix Table 59

Summary of Mean Scores by Class for the Dependent and Independent Variables, Unit II, Pretest A - Posttest B.

Class	N	Mean Posttest B	Standard Deviation Posttest B	Adjusted Mean Posttest B	Mean Pretest A	Mean DAT Verbal	Mean DAT Numer.	Mean DAT Total	Mean DRT Comp.	Mean DRT Speed	Mean Res-Gain
1021	13	59.2308	9.9846	59.9650	46.6923	12.4615	10.3077	22.7692	22.6923	44.3077	- 7.1857
1032	15	58.6667	10.7615	59.9810	44.5333	17.5333	13.8667	31.4000	25.7333	45.0000	- 7.1696
1052	6	62.0000	10.3537	63.7263	43.0000	12.0000	5.6667	17.6667	15.1667	22.0000	- 3.4243
1072	3	57.3333	10.0665	56.1040	54.0000	14.0000	7.3333	21.3333	15.3333	28.3333	-11.0467
1081	3	68.0000	4.0000	68.3828	48.0000	9.3333	6.3333	15.6667	17.0000	24.0000	1.2322
1092	3	68.0000	34.8712	69.4576	44.0000	8.6667	3.6667	12.3333	20.3333	27.3333	2.3070
1131	8	59.5000	9.4264	57.8340	55.6250	26.1250	19.1250	45.2500	23.6250	35.3750	- 9.3166
1141	6	60.6667	18.8326	61.6765	45.6667	14.6667	8.6667	23.3333	20.1667	30.5000	- 5.4742
1143	5	54.4000	19.3080	53.9230	51.2000	20.8000	11.6000	32.4000	23.2000	34.2000	-13.2276
1144	5	61.0000	16.1555	62.8338	42.6000	18.4000	8.8000	27.2000	25.8000	38.6000	- 4.3168
1145	4	54.0000	24.1109	53.1737	52.5000	20.5000	8.2500	28.7500	26.5000	44.5000	-13.9769
1152	9	61.4444	16.9640	63.4992	41.7778	13.0000	6.3333	19.3333	16.3333	29.0000	- 3.6514
1153	6	72.6667	18.1402	72.2434	51.0000	17.3333	11.1667	28.5000	22.0000	35.0000	5.0928
1154	10	75.7000	10.5415	74.6856	53.2000	18.7000	11.8000	30.5000	24.8000	38.0000	7.5350
1171	9	62.4444	21.2727	61.9913	51.1111	10.6667	6.6667	17.3333	18.0000	26.8889	- 5.1593
1181	11	57.8182	10.9345	59.0315	44.9091	10.9091	10.6364	21.5455	19.3636	30.6364	- 8.1191

Appendix Table 59 (continued)

Class	N	Mean Posttest B	Standard Deviation Posttest B	Adjusted Mean Posttest B	Mean Pretest A	Mean DAT Verbal	Mean DAT Numer.	Mean DAT Total	Mean DRT Comp.	Mean DRT Speed	Mean Res-Gain
1192	4	55.2500	15.1300	56.2374	45.7500	6.7500	6.000	12.7500	11.7500	23.5000	-10.9132
1201	7	56.7143	11.7575	59.9377	37.4286	9.4286	10.5714	20.0000	16.4286	25.2857	- 7.2130
1221	10	74.9000	12.0596	77.0831	41.3000	13.8000	8.5000	22.3000	20.7000	31.8000	9.9325
1222	10	65.6000	10.5325	66.5202	46.0000	13.4000	12.2000	25.6000	21.5000	32.3000	- 0.6304
1231	18	65.0556	12.9591	64.6323	51.0000	15.8333	11.5000	27.3333	20.8889	35.2222	- 2.5183
1241	7	72.2857	11.1013	73.2059	46.0000	17.4286	15.0000	32.4286	24.0000	40.7143	6.0553
1251	7	55.5714	12.8044	57.2210	43.2857	14.8571	8.5714	23.4286	15.0000	28.8571	- 9.9296
1301	6	62.6667	16.3299	64.1243	44.0000	21.6667	14.8333	36.5000	21.6667	39.1667	- 3.0263
1302	8	59.5000	16.0624	61.3271	42.6250	14.5000	13.7500	28.2500	16.3750	25.0000	- 5.8235
1303	6	64.6667	15.0555	63.3477	54.3333	18.3333	17.6667	36.0000	20.5000	31.5000	- 3.8029
1321	13	85.0000	19.2267	79.9261	68.3077	28.9231	24.7692	53.6923	30.5385	54.4615	12.7755
1322	13	92.9231	12.6653	90.4122	58.7692	30.0769	28.3077	58.3846	30.7692	62.9231	23.2616
1323	13	75.7500	16.1815	73.2219	58.8333	30.2500	25.3333	55.5833	29.9167	59.5833	5.0606
1324	11	93.9091	12.3649	91.3606	58.9091	32.5455	28.8182	61.3636	30.7273	60.8182	24.2100
1351	11	57.1818	15.3416	59.0791	42.3636	14.8182	14.1818	29.0000	17.6364	34.2727	- 8.0715

Appendix Table 60

Summary of Mean Scores by Class for the Dependent and Independent Variables,
Unit II, Pretest B - Posttest A.

Class	N	Mean Posttest A	Standard Deviation Posttest A	Adjusted Mean Posttest A	Mean Pretest B	Mean DAT Verbal	Mean DAT Numer.	Mean DAT Total	Mean DRT Comp.	Mean DRT Speed	Mean Res-Gain
1021	11	67.4546	12.9643	68.6569	54.0000	15.9091	12.2727	28.1818	24.6364	45.0909	4.2219
1032	14	61.3571	11.8556	63.0819	52.0714	16.2143	13.1429	29.3571	23.2857	42.1429	- 1.3531
1052	6	61.6667	19.8662	62.8239	54.1667	13.3333	9.1667	22.5000	18.1667	26.8333	- 1.6111
1072	5	50.8000	12.9306	51.2440	56.8000	9.0000	7.2000	16.2000	12.2000	23.6000	-13.1910
1081	6	60.0000	8.0000	59.9383	58.6667	14.5000	7.8333	22.3333	24.5000	33.8333	- 4.4967
1092	6	55.5000	7.7910	56.5218	54.6667	9.1667	7.5000	16.6667	19.0000	31.3333	- 7.9132
1131	6	60.0000	10.4307	59.3966	60.6667	24.3333	22.0000	46.3333	23.6667	39.3333	- 5.0384
1141	5	55.2000	11.0996	56.2940	54.4000	12.2000	7.2000	19.4000	18.4000	32.2000	- 8.1410
1143	6	55.3333	5.8878	56.1746	55.3333	12.5000	8.8333	21.3333	19.8333	31.6667	- 8.2605
1144	5	63.2000	6.5727	63.2106	58.4000	17.0000	8.2000	25.2000	23.6000	34.4000	- 1.2244
1145	6	56.0000	12.8996	56.4801	56.6667	16.3333	14.1667	30.5000	23.3333	41.1667	- 7.9549
1152	8	58.6250	12.5691	60.1660	52.7500	15.0000	9.3750	24.3750	20.3750	32.2500	- 4.2691
1153	8	63.0000	14.1421	61.4599	64.1250	19.8750	11.0000	30.8750	21.1250	36.3750	- 2.9751
1154	5	54.0000	15.3883	55.2232	55.4000	13.8000	11.6000	25.4000	14.2000	21.2000	- 9.2118
1171	8	53.7500	8.1020	56.2728	49.1250	10.0000	5.3750	15.3750	19.3750	27.1250	- 8.1622
1181	10	52.2000	9.7274	54.9192	48.4000	11.9000	9.0000	20.9000	17.7000	32.8000	- 9.5158

Appendix Table 60 (continued)

Class	N	Mean Posttest A	Standard Deviation Posttest A	Adjusted Mean Posttest A	Mean Pretest B	Mean DAT Verbal	Mean DAT Numer.	Mean DAT Total	Mean DRT Comp.	Mean DRT Speed	Mean Res. Gain
1192	3	40.0000	6.9282	43.5499	45.3333	11.3333	11.3333	22.6667	12.3333	24.3333	-20.8852
1201	5	57.6000	7.7974	59.0191	53.2000	13.6000	13.0000	26.6000	18.0000	29.8000	- 5.4160
1221	7	62.8571	11.2462	63.5565	55.8571	11.1429	7.8571	19.0000	19.7143	31.0000	- 0.8785
1222	8	73.5000	14.1724	75.5150	51.0000	16.0000	12.7500	28.7500	23.0000	37.1250	11.0799
1231	15	66.0000	13.9130	65.7397	59.4000	17.6667	14.6000	32.2667	24.0667	42.2000	1.3047
1241	4	58.0000	7.6594	60.8276	48.0000	19.7500	11.5000	31.2500	24.2500	33.7500	- 3.6075
1251	6	56.0000	13.3866	57.9247	51.3333	20.3333	19.1667	39.5000	22.0000	37.6667	- 6.5103
1301	8	54.2500	12.8480	56.5020	50.1250	17.6250	15.8750	33.5000	18.2500	33.1250	- 7.9331
1302	6	52.0000	24.0000	54.8276	48.0000	18.5000	13.5000	32.0000	18.8333	34.0000	- 9.6075
1303	7	46.0000	6.2183	47.1250	54.2857	13.7143	14.7143	28.4286	22.0000	37.5714	-17.3100
1321	15	85.7333	23.6023	80.1099	79.2000	31.1333	25.0000	56.1333	30.8000	56.8667	15.6750
1322	13	97.5385	17.5718	93.3652	73.8462	31.5385	27.1539	58.6923	32.3077	62.0769	28.9303
1323	9	88.8889	22.5191	85.5769	70.6667	33.3333	27.4444	60.7778	32.2222	65.0000	24.0273
1324	12	83.6667	21.7395	79.3163	74.5000	30.4167	27.9167	58.3333	31.4167	61.9167	14.8814
1351	13	53.5385	9.4217	54.0324	56.6154	14.6923	16.7692	31.4615	19.0769	35.1539	-10.4026

Appendix Table 61

Summary of Mean Scores by Class for the Dependent and Independent Variables, Unit III, Pretest A - Posttest B.

Class	N	Mean Posttest B	Standard Deviation Posttest B	Adjusted Mean Posttest B	Mean Pretest A	Mean DAT Verbal	Mean DAT Numer.	Mean DAT Total	Mean DRT Comp.	Mean DRT Speed	Mean Res. Gain
1021	10	86.8000	10.5071	84.7823	68.4000	17.0000	12.2000	29.3000	26.6000	47.9000	9.0687
1032	16	71.3750	16.2270	71.9986	63.0625	17.5000	11.3750	28.8750	23.0000	42.5000	- 3.7150
1052	11	81.9091	13.8018	81.1241	65.9091	12.8182	9.0000	21.8182	18.9091	26.8182	5.4104
1061	4	85.2500	4.7170	92.2140	50.2500	9.5000	8.2500	17.7500	18.2500	29.0000	16.5004
1072	4	75.0000	10.5198	74.5411	65.2500	12.7500	9.5000	22.2500	12.5000	24.7500	- 1.1725
1081	6	77.3333	7.0048	79.0601	60.8333	15.0000	6.5000	21.5000	21.3333	34.6667	3.3464
1092	8	71.0000	14.3328	66.8297	72.7500	9.5000	6.1250	15.6250	18.3750	32.1250	- 8.8840
1101	6	71.5000	22.5544	69.1029	69.1667	15.8333	8.6667	24.5000	20.3333	38.6667	- 6.6107
1131	8	81.0000	14.6190	78.9328	68.5000	26.0000	22.0000	48.0000	21.6250	33.6250	3.2192
1141	5	68.2000	20.0050	72.6155	55.4000	13.2000	8.2000	21.4000	20.0000	30.4000	- 3.0981
1144	4	76.0000	10.8321	81.6031	53.0000	19.5000	12.7500	32.2500	24.2500	37.7500	5.8895
1145	5	87.2000	15.5949	78.8481	81.2000	23.2000	15.6000	38.8000	22.4000	39.0000	3.1345
1152	7	74.1429	22.8796	74.5853	63.4286	15.5714	8.1429	23.7143	19.7143	35.8571	- 1.1283
1153	8	88.6250	11.4010	84.4547	72.7500	18.1250	10.7500	28.8750	21.1250	36.6250	8.7410
1154	5	77.0000	13.9642	72.0132	74.4000	14.6000	13.8000	28.4000	19.8000	34.2000	- 3.7005
1171	8	67.5000	22.0584	75.8249	47.5000	11.0000	5.3750	16.3750	18.5000	27.2500	0.1113

Appendix Table 61 (continued)

Class	N	Mean Posttest B	Standard Deviation Posttest B	Adjusted Mean Posttest B	Mean Pretest A	Mean DAT Verbal	Mean DAT Numer.	Mean DAT Total	Mean DRT Comp.	Mean DRT Speed	Mean Res. Gain
1181	12	62.3333	21.6557	67.8540	53.1667	11.6667	10.0833	21.7500	16.5833	28.4167	- 7.8596
1201	5	82.4000	19.5141	85.3309	58.4000	11.6000	11.8000	2[illegible].4000	15.8000	22.2000	9.6173
1221	8	74.5000	19.1162	75.1546	63.0000	12.2500	8.3750	20.6250	19.7500	27.7500	- 0.5591
1222	8	75.8750	15.9682	75.9729	64.1250	12.2500	10.7500	23.0000	19.0000	28.0000	0.2592
1231	17	82.4118	15.8077	83.2410	62.6471	15.7059	13.1765	28.8824	23.5882	40.7647	7.5273
1241	6	84.6667	6.4083	79.2180	75.3333	20.8333	14.5000	35.3333	24.0000	42.5000	3.5043
1251	7	83.4286	14.5012	78.0741	75.1429	22.0000	13.8571	35.8571	22.5714	42.8571	2.3605
1292	6	74.0000	20.5134	76.7990	58.6667	11.1667	10.6667	21.8333	18.5000	32.5000	1.0853
1301	7	75.4286	16.5616	73.2554	68.7143	18.4286	15.0000	33.4286	22.5714	39.2857	- 2.4583
1302	6	72.1667	16.4489	72.9037	62.8333	15.8333	12.5000	28.3333	13.6667	25.6667	- 2.8099
1303	6	73.3333	15.1085	74.4828	62.0000	12.6667	13.5000	26.1667	18.3333	32.1667	- 1.2309
1341	7	60.1429	18.1882	61.7165	61.1429	9.7143	3.5714	13.2857	16.4286	29.8571	-13.9972
1351	10	64.0000	22.7059	61.7844	68.8000	15.2000	13.9000	29.1000	19.4000	34.5000	-13.9293

Appendix Table 62

Summary of Mean Scores by Class for Dependent and Independent Variables,
Unit III, Pretest B - Posttest A.

Class	N	Mean Posttest A	Standard Deviation Posttest A	Adjusted Mean Posttest A	Mean Pretest B	Mean DAT Verbal	Mean DAT Numer.	Mean DAT Total	Mean DRT Comp.	Mean DRT Speed	Mean Res. Gain
1021	14	71.5000	12.3957	75.5755	57.7857	12.1429	9.8571	22.0000	20.7857	41.3571	- 1.0795
1032	11	78.3636	20.3729	81.8949	58.8182	16.3636	16.0909	32.7273	25.9091	42.9091	5.2400
1052	5	80.0000	6.3246	76.1616	72.8000	13.0000	4.4000	17.4000	14.2000	21.8000	- 0.4934
1061	8	80.3750	12.2117	76.6947	72.5000	14.0000	7.5000	21.5000	21.2500	33.2500	0.0398
1072	10	66.1000	18.7762	64.7389	68.1000	11.6000	6.9000	18.5000	17.1000	31.0000	-11.9160
1081	6	86.0000	8.6718	78.3665	80.0000	13.1667	5.5000	18.6667	22.8333	36.8333	1.7116
1092	7	76.7143	16.7602	71.4151	75.5714	11.8571	6.4286	18.2857	21.0000	29.7143	- 5.2399
1101	7	67.4286	23.4866	68.8309	62.8571	13.4286	10.5714	24.0000	18.1429	31.0000	- 7.8240
1131	7	86.8571	7.1979	85.2476	68.5714	26.4286	18.4286	44.8571	26.1429	40.1429	8.5926
1141	5	65.6000	15.3883	66.4000	64.0000	13.6000	9.2000	22.8000	18.0000	29.2000	-10.2550
1144	5	74.4000	18.0222	74.5675	65.2000	13.4000	7.4000	20.8000	19.2000	28.4000	- 2.0875
1145	5	85.6000	14.5877	81.6562	73.0000	14.4000	7.8000	22.2000	25.2000	45.6000	5.0012
1152	9	80.8889	12.4544	79.9905	67.2222	12.1111	6.3333	18.4444	18.2222	27.4444	3.3355
1153	7	81.7143	18.0159	77.6951	73.1429	17.5714	10.4286	28.0000	21.7143	33.1429	1.0402
1154	9	82.3333	13.0767	77.5110	74.6667	17.4444	13.4444	30.8889	22.8889	32.4444	0.8561
1171	10	72.9000	16.0031	76.4408	58.8000	9.4000	3.8000	13.2000	15.9000	24.9000	- 0.2141

Appendix Table 62 (continued)

Class	N	Mean Posttest A	Standard Deviation Posttest A	Adjusted Mean Posttest A	Mean Pretest B	Mean DAT Verbal	Mean DAT Numer.	Mean DAT Total	Mean DRT Comp.	Mean DRT Speed	Mean Res. Gain
1181	10	75.6000	10.2328	73.6591	69.2000	10.7000	10.2000	20.9000	22.4000	36.5000	- 2.9958
1201	4	74.2500	17.0172	81.3751	52.0000	12.0000	11.0000	23.0000	18.0000	29.5000	4.7201
1221	10	83.3000	16.6403	85.2596	61.8000	14.7000	9.7000	24.4000	21.3000	34.3000	8.6046
1222	10	89.6000	11.0272	86.7630	70.9000	17.5000	12.5000	30.0000	25.1000	40.3000	10.1081
1231	15	79.6667	12.1988	82.1533	60.8000	15.9333	9.5333	25.4667	18.5333	32.0000	5.4984
1241	6	86.0000	9.3808	78.0151	80.6667	21.0000	14.3333	35.3333	26.5000	43.5000	1.3602
1251	7	69.8571	22.2743	69.0758	67.0000	15.7143	13.4286	29.1429	17.0000	25.0000	- 7.5791
1292	4	75.0000	15.4488	74.7458	66.0000	20.2500	17.5000	37.7500	23.7500	37.0000	- 1.9091
1301	6	69.3333	27.5584	71.4510	61.5000	23.1667	15.5000	38.6667	20.0000	39.3333	- 5.2039
1302	7	81.4286	7.3679	86.7465	55.4286	16.5714	14.8571	31.4286	20.1429	29.5714	10.0915
1303	5	71.2000	19.4731	70.7350	66.4000	19.8000	19.8000	39.6000	22.8000	34.8000	- 5.9200
1341	4	67.2500	20.3859	72.2667	56.0000	15.2500	9.0000	24.2500	19.7500	35.0000	- 4.3882
1351	13	64.0769	20.0519	68.6071	56.9231	13.4615	16.6923	30.1539	16.7692	33.7692	- 8.0479

Appendix Table 63

Summary of Mean Scores by Class for the Dependent and Independent Variables, Unit IV, Pretest A - Posttest B.

Class	N	Mean Posttest B	Standard Deviation Posttest B	Adjusted Mean Posttest B	Mean Pretest A	Mean DAT Verbal	Mean DAT Numer.	Mean DAT Total	Mean DRT Comp.	Mean DRT Speed	Mean Res. Gain
1021	7	45.1429	18.1423	43.1800	49.4286	16.4286	12.5714	29.0000	21.4286	41.7143	- 1.4972
1032	14	46.1429	10.9042	45.7717	44.3571	16.8571	13.3571	30.2143	26.6429	48.2143	1.0945
1052	8	49.5000	11.0970	49.0056	44.7500	14.1250	6.3750	20.5000	17.2500	24.6250	4.3284
1061	7	43.7143	9.5344	40.9444	52.0000	14.7143	11.7143	26.4286	20.0000	31.7143	- 3.7328
1072	7	31.0000	11.1505	30.0684	46.1429	12.7143	6.2857	19.0000	16.7143	29.1429	-14.6088
1141	4	47.2500	9.2150	46.0494	47.0000	17.2500	15.2500	32.5000	23.0000	36.7500	1.3722
1143	5	50.6000	10.0896	52.7801	36.2000	18.6000	8.4000	21.0000	23.0000	37.4000	8.1119
1152	6	44.1667	16.8810	46.4185	36.0000	12.6667	5.6667	18.3333	18.0000	29.5000	1.7413
1153	8	43.5000	14.2528	43.8687	42.0000	15.7500	11.6250	27.3750	20.0000	29.8750	- 0.8085
1154	8	42.0000	19.5959	43.1533	39.5000	16.0000	13.1250	29.1250	19.0000	29.6250	- 1.5239
1171	6	32.0000	12.1326	35.0365	33.5000	10.8333	4.5000	15.3333	18.8333	28.5000	- 9.6407
1181	8	51.2500	11.3484	48.9509	50.5000	12.3750	9.7500	22.1250	24.0000	38.7500	4.2737
1201	5	38.4000	9.2087	38.8942	41.6000	11.6000	15.8000	27.4000	17.4000	28.4000	- 5.7830
1221	12	54.7500	16.3770	54.5171	43.9167	15.5833	10.5000	26.0833	20.0000	33.0000	9.8399
1222	5	52.8000	17.9778	50.2184	51.4000	16.4000	11.0000	27.4000	22.8000	35.4000	5.5412
1231	19	47.8421	19.8222	48.1777	42.1053	17.4211	11.6842	29.1053	22.2105	37.1579	3.5005

Appendix Table 63 (continued)

Class	N	Mean Posttest B	Standard Deviation Posttest B	Adjusted Mean Posttest B	Mean Pretest A	Mean DAT Verbal	Mean DAT Numer.	Mean DAT Total	Mean DRT Comp.	Mean DRT Speed	Mean Res. Gain
1241	5	52.0000	9.3808	50.7366	47.2000	17.6000	8.6000	26.2000	25.4000	40.0000	6.0594
1251	7	47.1429	14.5078	49.7085	35.0000	15.1429	14.2857	29.4286	16.1429	27.2857	5.0314
1291	7	43.4286	10.9371	44.0663	41.1429	12.1429	8.2857	20.4286	16.8571	31.7143	- 0.6109
1292	4	26.0000	9.5219	28.2518	36.0000	12.0000	12.7500	24.7500	16.0000	29.0000	-16.4254
1301	7	52.7143	18.4275	52.9484	42.4286	23.8571	17.1429	41.0000	23.1429	43.8571	8.2713
1302	7	40.0000	14.4222	39.7858	43.8571	14.0000	12.8571	26.8571	17.5714	28.2857	- 4.8914
1303	6	46.6667	7.8655	45.9891	45.3333	11.6667	12.8333	24.5000	17.3333	24.3333	1.3119
1333	4	30.2500	4.1933	32.7372	35.2500	5.000	3.7500	8.7500	8.0000	16.5000	-11.9400
1351	13	38.4615	9.5970	37.9128	44.9231	15.3077	16.1539	31.4615	17.7692	33.4615	- 6.7644

Appendix Table 64

Summary of Mean Scores by Class for the Dependent and Independent Variables, Unit IV, Pretest B - Posttest A.

Class	N	Mean Posttest A	Standard Deviation Posttest A	Adjusted Mean Posttest A	Mean Pretest B	Mean DAT Verbal	Mean DAT Numer.	Mean DAT Total	Mean DRT Comp.	Mean DRT Speed	Mean Res. Gain
1021	14	61.4286	14.6850	58.5803	38.4286	13.7857	10.7143	24.5000	24.9286	46.7857	5.7822
1032	16	60.7500	12.2393	59.9368	34.6875	17.6875	13.5000	31.1875	23.6250	42.2500	[illegible].1387
1052	8	56.7500	16.2722	54.4748	37.3750	11.5000	8.7500	20.2500	17.0000	24.5000	1.6767
1061	9	56.4444	13.4825	55.5821	34.7778	10.2222	6.1111	16.3333	16.8889	25.8889	2.7840
1072	6	41.3333	10.0133	37.9929	39.3333	10.5000	9.5000	20.0000	14.3333	28.5000	-14.8052
1141	6	42.0000	12.0665	43.0113	31.3333	12.1667	5.8333	18.0000	18.0000	29.5000	- 9.7867
1143	6	56.6667	10.2502	57.3154	32.0000	15.8333	11.3333	27.1667	20.8333	34.5000	4.5173
1152	6	45.6667	14.3341	50.9391	23.5000	11.5000	9.1667	20.6667	15.8333	27.1667	- 1.8589
1153	6	49.3333	20.1858	49.2567	33.3333	18.0000	10.0000	28.0000	20.3333	35.3333	- 3.5413
1154	9	57.3333	12.0000	53.6302	40.0000	17.6667	10.7778	28.4444	24.1111	39.3333	0.8321
1171	5	42.6000	15.9938	43.2487	32.0000	10.0000	6.8000	16.8000	19.2000	28.8000	- 9.5494
1181	11	56.4546	17.4320	59.3286	27.9091	10.8182	10.4546	21.2727	15.1818	25.9091	6.5306
1201	5	55.2000	8.1976	62.1588	20.4000	8.8000	5.0000	13.8000	12.2000	18.4000	9.3608
1221	10	49.6000	14.7513	50.5751	31.4000	11.7000	6.6000	18.3000	20.0000	28.9000	- 2.2230
1222	12	51.0000	8.8831	51.7847	31.7500	13.4167	12.8333	26.2500	21.6667	33.4167	- 1.0134
1231	20	49.2500	15.5492	48.5388	34.5000	15.4000	11.2000	26.6000	20.9000	36.6500	- 4.2593

Appendix Table 64 (continued)

Class	N	Mean Posttest A	Standard Deviation Posttest A	Adjusted Mean Posttest A	Mean Pretest B	Mean DAT Verbal	Mean DAT Numer.	Mean DAT Total	Mean DRT Comp.	Mean DRT Speed	Mean Res. Gain
1241	10	60.1000	13.5684	60.5311	32.4000	22.0000	17.3000	39.3000	24.8000	42.8000	7.7330
1251	7	52.5714	12.7391	53.6087	31.2857	21.2857	13.5714	34.8571	21.5714	38.2857	0.8106
1291	4	46.0000	23.2092	51.4085	23.2500	11.2500	11.5000	22.5000	19.7500	31.5000	- 1.3895
1292	5	64.8000	21.6148	65.0135	32.8000	14.0000	16.8000	30.8000	19.6000	32.2000	12.2155
1301	7	42.8571	14.9156	44.4384	30.2857	16.2857	14.0000	30.2857	18.1429	31.4286	- 8.3597
1302	6	62.1667	20.6922	59.7328	37.6667	19.0000	15.8333	34.8333	17.6667	27.5000	6.9348
1303	8	49.0000	19.2131	46.1128	38.5000	17.1250	17.3750	34.5000	21.1250	37.5000	- 6.6852
1333	5	45.8000	12.6570	48.1894	28.8000	7.0000	4.8000	11.8000	10.8000	18.4000	- 4.6086
1351	12	46.0000	15.7711	45.7421	33.6667	12.4167	14.4167	26.8333	17.8333	33.1667	- 7.0560

APPENDIX H

TEACHER ADDRESSES

Sister Elinore Davis
Visitation High School
900 West Garfield Blvd.
Chicago, Illinois 60609

Mrs. Dorothy Bender
Maryvale High School
3415 North 59th Street
Phoenix, Arizona 85033

Mrs. Gayle Jarvis
Maryvale High School
3415 North 59th Street
Phoenix, Arizona 85033

Ronald Grossarth
Camelback High School
4612 North 28th Street
Phoenix, Arizona 85016

Thomas Johnson
Badger High School
Lake Geneva, Wisconsin 53147

Ted Tsumura
Manual High School
1700 28th Street
Denver, Colorado 80202

Brother J. M. DeLibero
Bishop Kearney High School
135 Kings Highway South
Rochester, New York 14617

Douglas Fox
Flathead High School
Kalispell, Montana 59901

Reginald Dumontier
Flathead High School
Kalispell, Montana 59901

Kenneth Bower
East Jefferson High School
400 Phlox
Metairie, Louisiana 70001

John Woodruff
Kearney High School
San Diego, California 92111

Mrs. Kaye Brown
Theodore High School
Theodore, Alabama 36582

Miss Julia Markey
Motts High School
3131 Twelve Mile Road
Warren, Michigan 48090

Richard Denovellos
Titusville High School
Washington Avenue
Titusville, Florida 32780

Mrs. Cynthia Kaufman
Danbury High School
Danbury, Connecticut 06810

Mrs. Mathews
Danbury High School
Danbury, Connecticut 06810

Henry R. Drexler, Jr.
Dixie Hollins High School
4940 62nd Street North
St. Petersburg, Florida 33708

Joseph Michel
Richfield Senior High School
70th and Harriet Avenue
Minneapolis, Minnesota 55423

Mr. L. Richardson
Brattleboro Union High School
Brattleboro, Vermont 05301

Mr. B. Macfarland
Brattleboro Union High School
Brattleboro, Vermont 05301

Bruce Evans
West High School
951 Elati Street
Denver, Colorado 80201

William Kingsley
West High School
951 Elati Street
Denver, Colorado 80201

John H. Powell
Addison High School
1220 5th Street, N.W.
Roanoke, Virginia 24016

Mrs. Nadine Petersen
Oak-Park-River-Forest
  High School
Oak Park, Illinois 60302

James E. McCracken
Dixie Hollins High School
4940 62nd Street North
St. Petersburg, Florida 33708

H. L. Roach
L. W. Higgins High School
1500 Berger Road
Marrero, Louisiana 70072

Leonard Wright
Woodrow Wilson High School
240 Stanford Road
Beckley, West Virginia 24016

Emmett L. Procter
Carver High School
1275 Capitol Avenue, S.W.
Atlanta, Georgia 30315

Burleigh Turner
Cunning-Bedford High School
St. Georges, Delaware 19733

Henry Buinicky
Newport High School
Newport, New Hampshire 03773

APPENDIX I

TEACHER QUESTIONNAIRE

BIOLOGICAL SCIENCES CURRICULUM STUDY
UNIVERSITY OF COLORADO • P.O. BOX 930
BOULDER, COLORADO 80302

TO: Dr. Thomas J. Cleaver, Consultant
BSCS, Boulder, Colorado

(Check One)

_______ I will be able to participate in the SM evaluation project.

_______ I will not be able to participate in the SM evaluation project.

Signed: ____________________________

School Name: _______________________

Address: ___________________________

How many SM classes will you be teaching? ________

Approximately how many students per class? _______

Students enrolled in my SM classes will come primarily from

(Check One) _________ Urban Middle Class Homes

_________ Inner City (Ghetto) Homes

_________ Suburban Middle or Upper-Class Homes

_________ Rural, Small Town

_________ Other (Please Describe)

APPENDIX J

TEST INSTRUMENTS

FORM A

BIOLOGICAL SCIENCES CURRICULUM STUDY

BSCS Biology, SM Evaluation
1968-69
Ecology Unit Test

DIRECTIONS

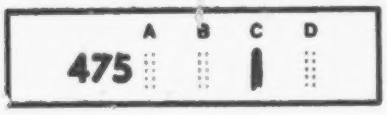
Each question in this test is followed by four choices. Only one of these is the best answer. Read each question and then decide which is the best answer. On the separate answer sheet find the row which has the same number as the question you are answering. In that row blacken the space between the dotted lines under the letter which is the same as the one in front of the answer you choose. Make your marks heavy and black. If you make a mistake, erase completely. If you have to write out an arithmetic problem, use the margin of your answer sheet.

Look at the example below:

475. Heat is a form of

(A) life.
(B) matter.
(C) energy.
(D) work.

Sample of Answer Sheet



Make no marks in this booklet. Do not open this booklet until told to do so.

Special Materials
ECOLOGY UNIT TEST

Form A

1. The forms of plant and animal life which will develop and continue to live in a community over a period of many years depends upon

   (A) the temperature, the soil, and the rainfall.
   (B) the number of large predators in the community.
   (C) whether there are enough green plants to support the first-order consumers.
   (D) whether there are enough microorganisms in the soil.

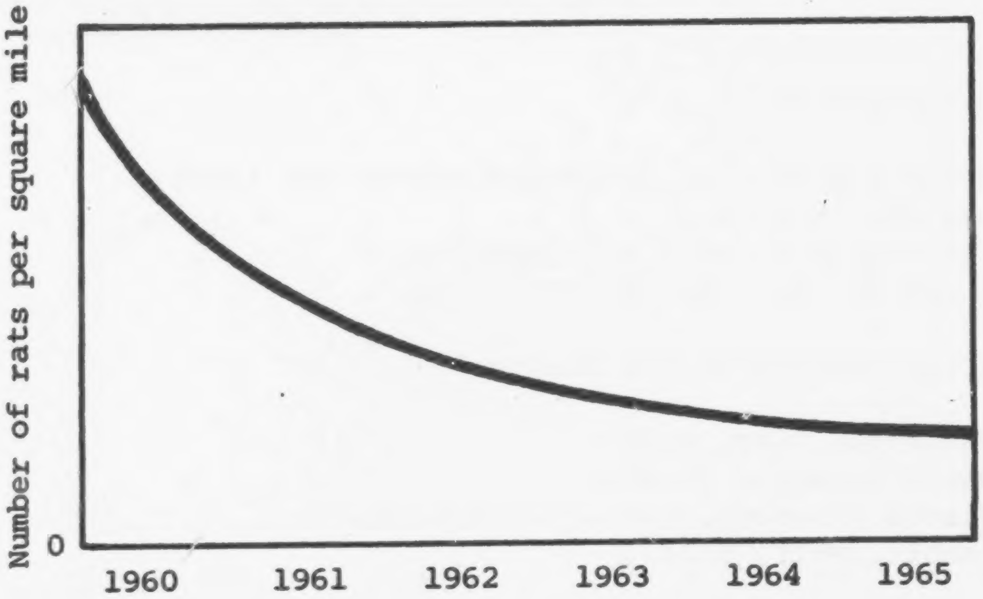
2. Biologists most often classify plants and animals by

   (A) their color.
   (B) where they live.
   (C) their structure.
   (D) how they behave.

3. A planarian worm was placed in a dish and exposed to bright light so that the effect of light on the worm could be studied. In the same experiment, a second worm was placed in a dish kept in the dark. Why was the second worm included in the experiment?

   (A) Two worms are better than one when completing a controlled experiment.
   (B) The second worm is unnecessary
   (C) The second worm is necessary in case the first one gets sick during the experiment
   (D) The second worm would let us know if any factor other than light was affecting the worm.

Questions 4-5 are based on the following diagram showing the changes in the density of rats in a small city from 1960 to 1965.



4. During 1960 the number of rats per square mile was

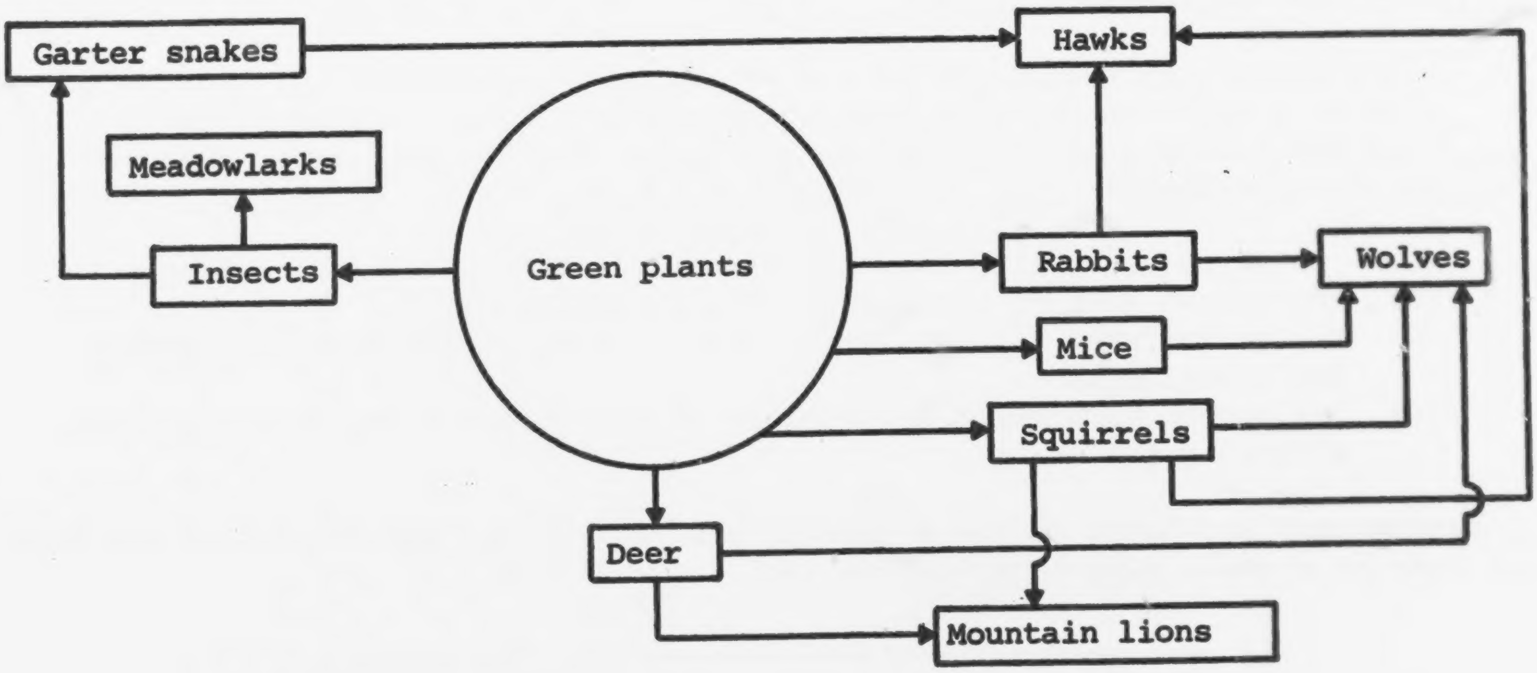
   (A) increasing.
   (B) less than in 1965
   (C) the same as in 1965
   (D) greater than in 1965

5. The period of greatest change in the density of rats occurred between

   (A) 1960 and 1961
   (B) 1961 and 1962
   (C) 1962 and 1963
   (D) 1963 and 1965

Questions 6-9 are based on the following:

The diagram represents a food web in a forest area. It shows how living things get their food. The arrows go from the food source to the consumer of that food.


Garter snakes
Hawks
Meadowlarks
Insects
Green plants
Rabbits
Wolves
Mice
Squirrels
Deer
Mountain lions

6. The food web shows that

   (A) rabbits eat plants, and hawks and wolves eat rabbits.
   (B) squirrels eat insects.
   (C) wolves eat rabbits, mice and insects.
   (D) insects are an important food of mice.

7. A food chain represented in the diagram is

   (A) hawk, squirrel, deer, wolf.
   (B) mice, hawk, insects, birds.
   (C) green plants, insects, garter snakes, hawks.
   (D) deer, rabbit, wolf, mice

8. If the meadowlarks are removed from this community, one would expect an increase in the number of

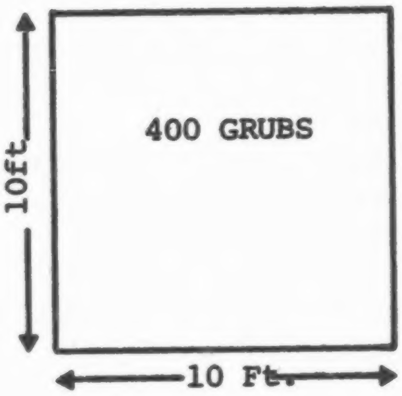
(A) mice.
(B) wolves.
(C) garter snakes.
(D) deer.

9. Mountain lions are removed to increase the deer in this area. If the deer were to increase in numbers, we would also expect an increase in

(A) rabbits.
(B) wolves.
(C) hawks.
(D) green plants.

10. It is estimated that there are 400 Japanese beetle grubs in a square of lawn measuring ten feet on each side. What is the density of the population of beetle grubs?

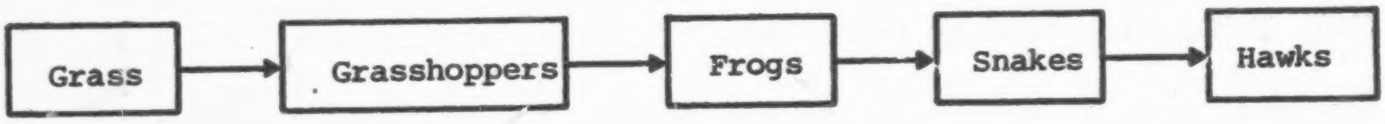
(A) 4 per square foot
(B) 8 per square foot
(C) 20 per square foot
(D) 40 per square foot



11. If you were asked to take a complete census of the potato beetles in a garden, you would

(A) count all of the beetles in the garden.
(B) catch several beetles for laboratory study.
(C) determine the effect of some factor (Such as the availability of food, water, sunshine) on increases or decreases in the number of beetles.
(D) estimate the total number of beetles from the numbers found in several small areas of the garden.

Questions 12-14 are based on the following diagram.



12. The diagram shows

(A) a nutrient medium.
(B) a population.
(C) an ecosystem.
(D) a food chain.

13. Which organism is the basic energy source for all of the other organisms shown in the diagram?

(A) hawks.
(B) grass.
(C) snakes.
(D) grasshoppers.

14. If, over a two year period all of the grass, all of the grasshoppers, all of the frogs, and so on in an area were weighed, you would find that the

(A) frogs weighed more than the grasshoppers
(B) hawks weighed more than the frogs.
(C) grasshoppers weighed more than the snakes.
(D) grasshoppers weighed more than the grass.

Questions 15-16 are based on the following:

Cultures of 2 species of animals are put into a pond. After six months, species X is gone, and species Y has increased.

15. A reasonable hypothesis would be that the pond environment is

(A) favorable for both species.
(B) favorable for X but unfavorable for Y.
(C) favorable for Y but unfavorable for X.
(D) favorable for neither species.

16. If no other organisms were in the pond, one might expect that population Y acted

(A) favorably on X.
(B) unfavorably on X.
(C) not at all on X.
(D) by increasing the rate of reproduction of X.

17. The following groups of plants were found in a small city park. Which of the groups is a population?

(A) large broad-leaf trees including maples, beeches and sycamores.
(B) several species of grass
(C) two kinds of flowering shrubs.
(D) tulips.

18. Population density refers to

(A) the average thickness and weight of individuals.
(B) how crowded individuals are.
(C) how well-adapted individuals are to their environment.
(D) how numerous individuals are.

19. If for some reason all of the living things in an area were destroyed, which forms of life would be the first to reappear in the area?

(A) strong, hardy trees such as oaks or maples.
(B) simple plants such as grasses.
(C) small animals which can reproduce rapidly, such as mice, rats, or rabbits.
(D) plants and animals adapted to desert conditions like cactus or lizards.

20. An hypothesis is

(A) a type of apparatus used in experiments.
(B) a fact proved by an experiment.
(C) a medium for some microscopic organisms
(D) a possible explanation of something.

21. The total number of organisms of a certain kind that live in a large area can be determined by counting the numbers in small areas and then estimating the total number. This technique involves

(A) taking samples.
(B) doing a complete census.
(C) developing one or more hypotheses.
(D) completing a controlled experiment.

22. Which of the following groupings is based on a difference in structure?

(A) Large animals, small animals
(B) Purple flowers, yellow flowers
(C) Internal skeleton, external skeleton
(D) Live in deserts, live near lakes.

23. An ecosystem contains

(A) plants only.
(B) animals only.
(C) plants and animals only.
(D) plants, animals and their non-living environment.

24. You wish to determine whether soaking seeds in water before planting them will affect the time needed for the seeds to sprout. You decide to soak some seeds, plant them, then count the seedlings that appear each day for a two week period.

A reasonable control for this experiment would be:

(A) Soak seeds for different lengths of time before planting.
(B) Plant some seeds without soaking them and count the seedlings for the same period of time.
(C) Soak seeds and then keep them for various periods of time before planting.
(D) Soak some of the seeds and plant them in other types of soil.

FORM B

BIOLOGICAL SCIENCES CURRICULUM STUDY

BSCS Biology, SM Evaluation
1968-69
Ecology Unit Test

DIRECTIONS

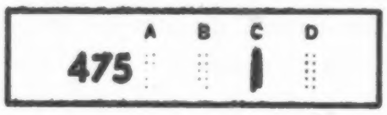
Each question in this test is followed by four choices. Only one of these is the best answer. Read each question and then decide which is the best answer. On the separate answer sheet find the row which has the same number as the question you are answering. In that row blacken the space between the dotted lines under the letter which is the same as the one in front of the answer you choose. Make your marks heavy and black. If you make a mistake, erase completely. If you have to write out an arithmetic problem, use the margin of your answer sheet.

Look at the example below:

475. Heat is a form of

(A) life.
(B) matter.
(C) energy.
(D) work.

Sample of Answer Sheet

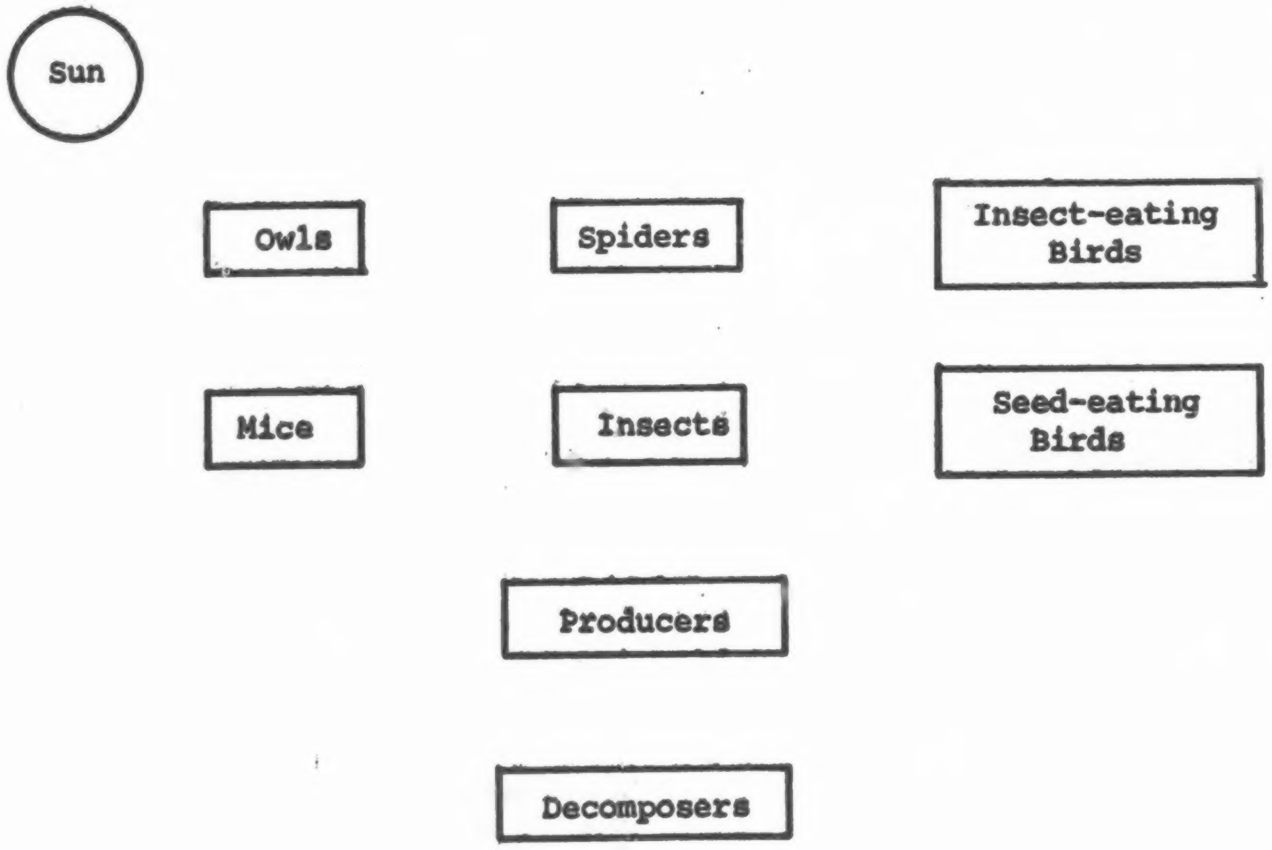


Make no marks in this booklet. Do not open this booklet until told to do so.

Special Materials
ECOLOGY UNIT TEST

Form B

Questions 1-2 are based on the following diagram:


Sun
Owls
Spiders
Insect-eating Birds
Mice
Insects
Seed-eating Birds
Producers
Decomposers

1. In the ecosystem diagrammed above, energy would normally flow from

   (A) insect-eating birds to seed-eating birds.
   (B) mice to producers
   (C) producers to insects
   (D) decomposers to sun.

2. Birds would be considered second-order consumers if they ate

   (A) insects.
   (B) spiders.
   (C) seeds.
   (D) decomposers.

3. Which of the following statements best describes the density of a population?

   (A) 500 rabbits in a square mile
   (B) 50 mice in a field
   (C) 2000 rats in midtown New York
   (D) 65 dogs

4. A population is

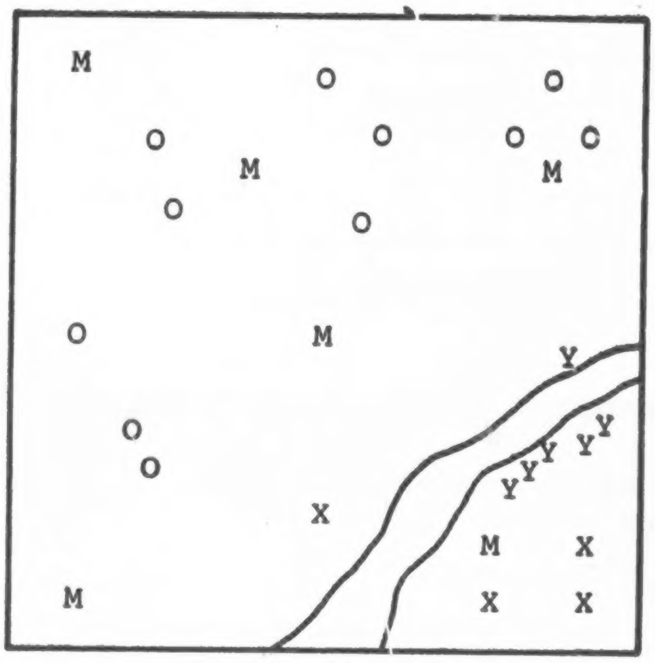
(A) all of the plants or animals of a certain kind (species).
(B) all of the plants or animals living in a certain place.
(C) all of the plants or animals of a certain kind that live in a certain place.
(D) all of the plants and animals which form a certain food chain.

5. Organisms which transform the energy of the sun into forms usable by other living things include

(A) fungi and bacteria.
(B) grass, trees and flowers.
(C) deer, rabbits, cows.
(D) lions, wolves, sharks.

Questions 6-9 are based on the following information.

A group of students marked off a plot of ground and mapped it as follows. The four kinds of plants they found are represented by the letters M, O, X and Y. Area of the plot was 3 acres.



A plot
3 Acres in Area

6. What is the density of M in the plot?

(A) less than 1 per acre
(B) 2 per acre
(C) 3 per acre
(D) 6 per acre

7. The students counted a total of 27 plants that were M, O, X, and Y. The density of these plants is

(A) 3 per acre.
(B) 6 per acre.
(C) 9 per acre.
(D) 27 per acre.

8. The kind of plant which seems best adapted to conditions of the entire plot is

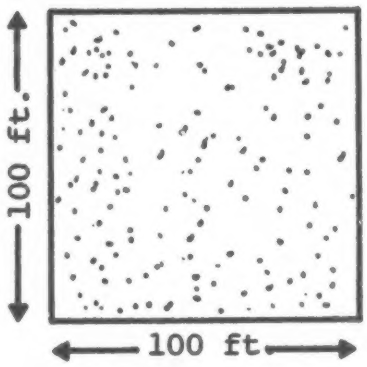
(A) M.
(B) O.
(C) X.
(D) Y.

9. The plant most dependent on water is

(A) M.
(B) O.
(C) X.
(D) Y.

10. A climax community is best described as a community that

(A) is in the first stages of succession.
(B) will not change very much
(C) will change a great deal
(D) has never gone through succession.



11. Each of the dots in the drawing represents a dandelion in a field. The most accurate way to find out how many dandelions there are is to

(A) count those along one edge and multiply by four.
(B) count all of them.
(C) sample with a one foot square.
(D) have an expert look at the field and give an estimate.

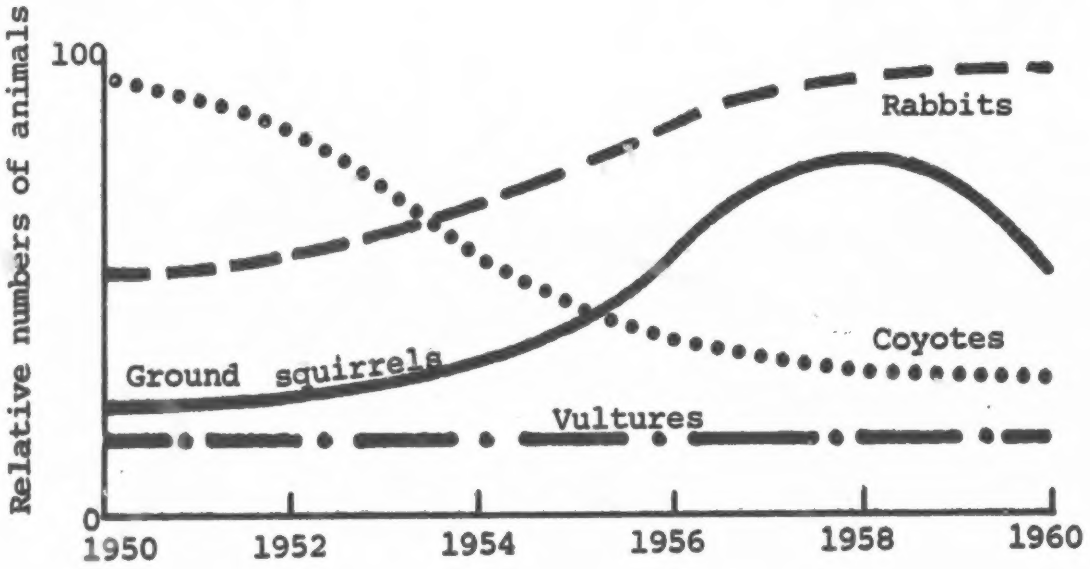
12. Grass, bushes, pine trees, small broad-leafed trees, rabbits, deer and mountain lions are among the plants and animals living in a mountainous region. One year there was no rain. What would probably happen as a result?

(A) The broad-leafed trees would begin to replace the pine tree.
(B) The number of rabbits in the region would increase sharply.
(C) The deer would grow long, thick coats.
(D) The number of mountain lions in the region would decrease.

13. A community is

(A) all of the plants or animals of a certain kind.
(B) all of the plants and animals that live in an area.
(C) the interaction of plants and animals with the non-living environment.
(D) all of the plants or animals counted in a census or sample

Questions 14-17 are based on the following information and graph.



14. In 1960, the coyote population

(A) had disappeared.
(B) was greater than in 1950
(C) remained about the same as in 1950
(D) was less than in 1950

15. The population showing the least change is that of

(A) ground squirrels.
(B) coyotes.
(C) vultures.
(D) rabbits.

16. The best explanation for the change in the rabbit population is that

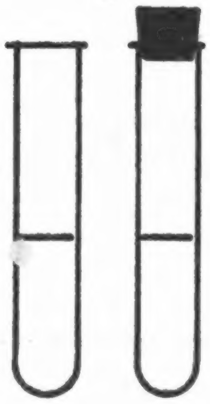
(A) coyotes eat rabbits.
(B) vultures eat rabbits.
(C) vultures eat ground squirrels
(D) coyotes eat ground squirrels.

17. The best explanation for the change in the ground squirrel population between 1958 and 1960 is that

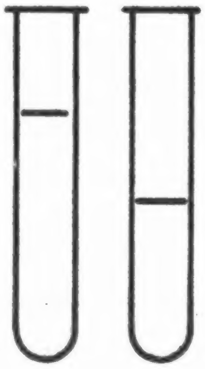
(A) the vulture population was decreasing.
(B) coyotes were eating more rabbits.
(C) rabbits and ground squirrels both eat grass.
(D) ground squirrels were reproducing more rapidly.

18. Does the air contain bacteria? Which one of the following experiments would you use to get an answer to this question? Each test tube contains sterilized food for the growth of bacteria.

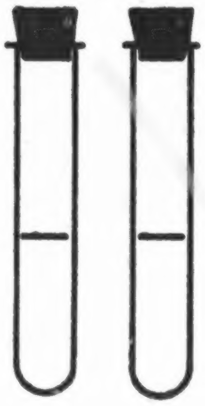
A



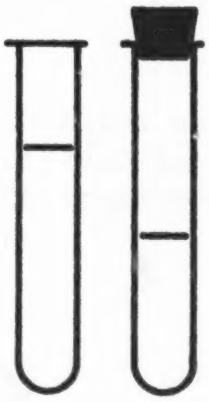
B



C



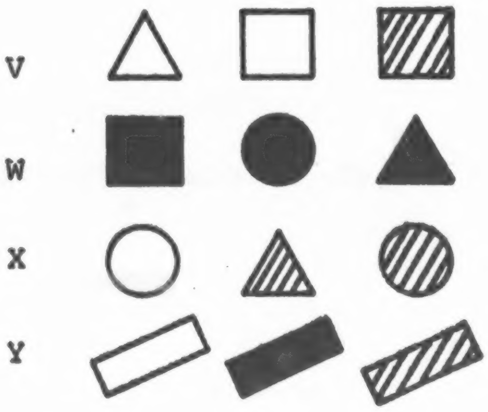
D



19. A statement about a factor which might explain the results of an experiment is

(A) a micrometer.
(B) a control.
(C) an ecosystem.
(D) an hypothesis.

Questions 20-22 are based on the following 4 rows of objects.



20. Which of the above rows shows the best grouping of objects by shape?

(A) V
(B) W
(C) X
(D) Y

21. Which of the above rows shows the best grouping of objects by color only?

(A) V
(B) W
(C) X
(D) Y

22. Which of the above rows is made up of things that are not related to things in any other row?

(A) V
(B) W
(C) X
(D) Y

23. The roots of corn seedlings were cut off at various distances from the end. Four days later the amount of growth of the roots was measured. The data was reported as shown below.

	Amount of root tip cut off			
	none	1 mm	3 mm	5 mm
Growth after 4 days	41.7 mm	28.4 mm	16.3 mm	8 mm

In this experiment the control was:

(A) No tip cut off
(B) 1 mm of the tip cut off
(C) 3 mm of the tip cut off
(D) 5 mm of the tip cut off

24. All plants in an area were killed. Probably the first plants to grow back would be

(A) oak trees.
(B) shrubs.
(C) annual weeds.
(D) cottonwood trees.

BIOLOGICAL SCIENCES CURRICULUM STUDY

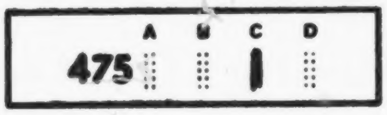
BSCS Biology, SM Evaluation
1968-69
Cell Energy Processes Unit Test

DIRECTIONS

Each question in this test is followed by four choices. Only one of these is the best answer. Read each question and then decide which is the best answer. On the separate answer sheet find the row which has the same number as the question you are answering. In that row blacken the space between the dotted lines under the letter which is the same as the one in front of the answer you choose. Make your marks heavy and black. If you make a mistake, erase completely. If you have to write out an arithmetic problem, use the margin of your answer sheet.

Look at the example below:

Sample of Answer Sheet



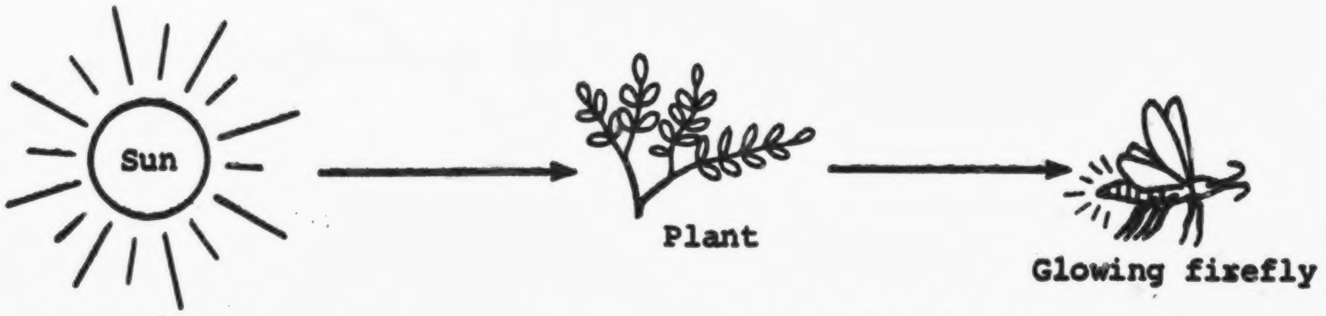
475. Heat is a form of

- (A) life.
- (B) matter.
- (C) energy.
- (D) work.

Make no marks in this booklet. Do not open this booklet until told to do so.

Special Materials
CELL ENERGY PROCESSES

Form A



1. The transformations of energy best represented by the diagram above are:

   (A) radiant to chemical, chemical to radiant.
   (B) radiant to heat, heat to radiant.
   (C) radiant to chemical, chemical to electrical.
   (D) chemical to radiant, radiant to heat.

2. The complete burning of fat will produce

   (A) heat and H_2O only.
   (B) CO_2 and heat only.
   (C) H_2O, heat, and CO_2.
   (D) O_2, CO_2, and heat.

Questions 3 and 4 are based on the following table.

Organism	Type	Characteristics
I	cold-blooded	nonmoving animal
II	cold-blooded	moving animal
III	warm-blooded	slow-moving animal
IV	warm-blooded	fast-moving animal

3. If these organisms are the same size which will need the most food?

   (A) I
   (B) II
   (C) III
   (D) IV

4. Organisms I and II are of the same size and weight. If I eats a greater weight of food than II, then the food eaten by

   (A) II probably has more calories per gram.
   (B) I probably has more calories per gram.
   (C) II probably has fewer calories per gram.
   (D) I and II probably has the same number of calories per gram.

Questions 5 and 6 are based on the following information:

A simple calorie is the amount of heat needed to raise the temperature of 1 cc of water one degree centigrade. A calorimeter uses heat from a fuel substance to heat a measured quantity of water. Sixteen grams of peanuts were burned in a calorimeter containing 10 grams of water.

substance	Water temperature at beginning	Water temperature at end
peanut	26° C	48.5° C

5. The number of simple calories needed to increase the water temperature to 27° C is

(A) 1
(B) 10
(C) 27
(D) 100

6. If the number of calories per gram =

$$\frac{\text{temperature difference X volume of water}}{\text{weight of sample}}$$

then peanuts produce

(A) 0.07 calories per gram.
(B) 0.14 calories per gram.
(C) 14.0 calories per gram.
(D) 1.0 calories per gram.

The following statements are true or false. Indicate true by blackening the space after the letter A on your answer sheet. Indicate false by blackening the space after the letter D.

7. Enzymes are destroyed as they function.

8. Enzymes cause chemical reactions to be speeded up.

9. Enzymes are always used in transforming energy.

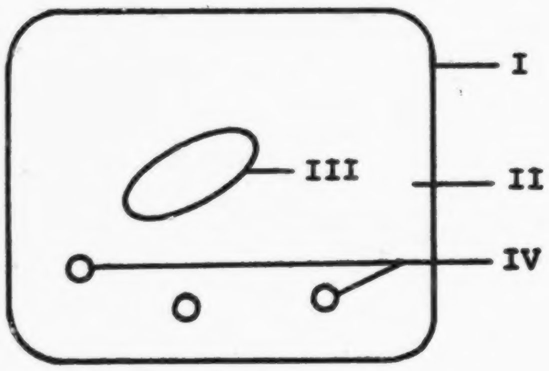
If the condition described below will generally increase enzyme action, blacken the space after the letter A on your answer sheet. If the condition will generally decrease enzyme action, blacken the space after the letter D on your answer sheet.

10. the temperature is raised to the boiling point of water.

11. the temperature is lowered a few degrees.

12. the amount of substance acted on is decreased.

Questions 13 and 14 refer to the following diagram.



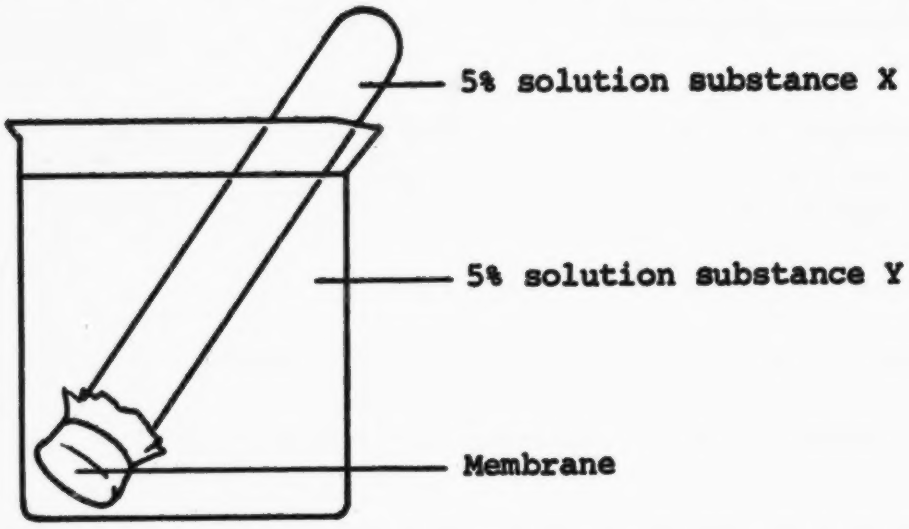
13. If the diagram is of a plant cell, then the chloroplasts might be represented by

(A) I
(B) II
(C) III
(D) IV

14. The structures found in all living things are

(A) I and II only
(B) I and IV only
(C) I, II, and III only
(D) I, II, and IV only

Questions 15 and 16 are based on the following diagram.



15. After several hours, molecules of Y were found in X but no X molecules were found in Y. This observation is best explained if X molecules

(A) have more energy than Y molecules.
(B) have less energy than Y molecules.
(C) are too large to pass through a membrane.
(D) are pushed into the test tube by Y molecules.

16. An enzyme is added to substance X and an entirely new substance, Z, is found outside the tube shortly thereafter. One can conclude that this is due to

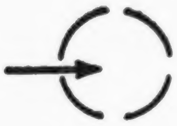
(A) digestion only.
(B) diffusion only.
(C) digestion and diffusion.
(D) respiration and fermenting.

17. A substance which does not pass through a cell membrane might be able to do so if its molecules

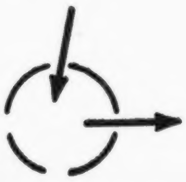
(A) moved faster.
(B) were smaller.
(C) were heavier.
(D) moved slower.

18. Which of the following is the best diagrammatic description of the movement of particles through cell membranes?

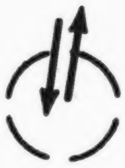
(A)



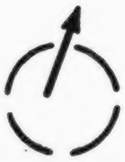
(B)

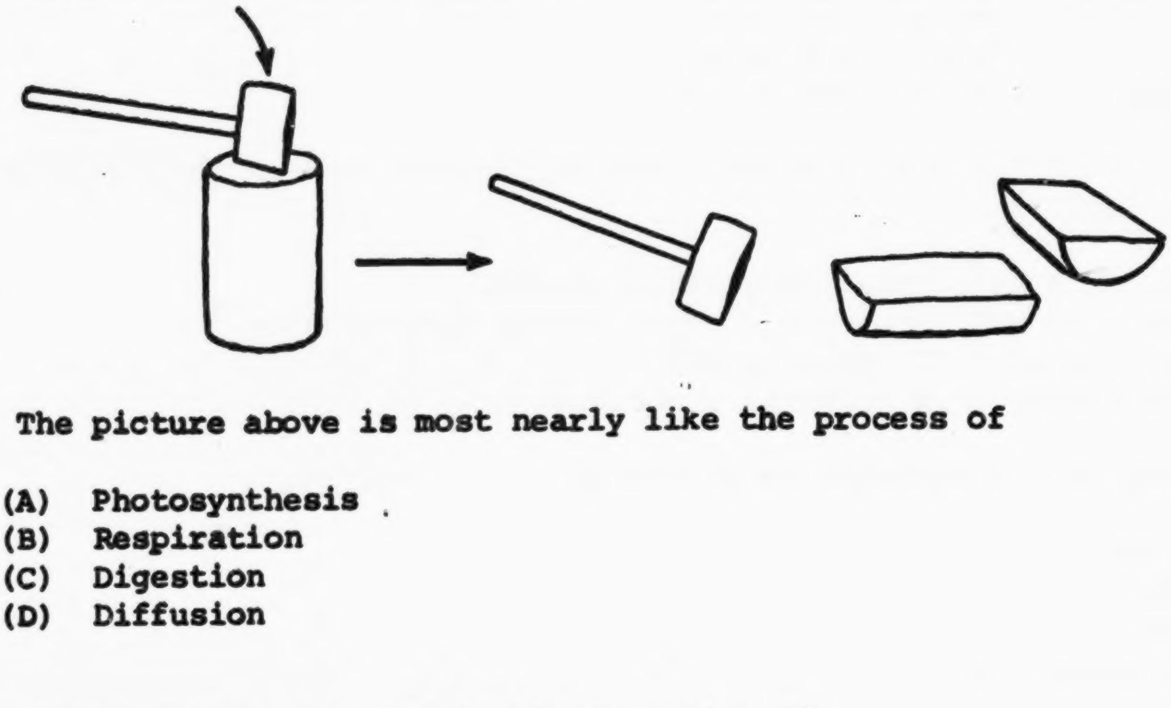


(C)



(D)





19. The picture above is most nearly like the process of

(A) Photosynthesis
(B) Respiration
(C) Digestion
(D) Diffusion

20. Photosynthesis results in the formation of

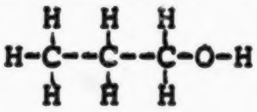
(A) starch and carbon dioxide
(B) urea and oxygen
(C) glucose and oxygen
(D) sucrose and water

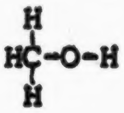
$$6H_2O + 6CO_2 \xrightarrow[\text{chlorophyll}]{} C_6H_{12}O_6 + 6O_2$$

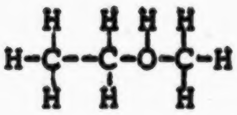
21. To complete the equation above for photosynthesis, add

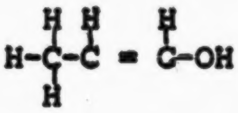
(A) 6 before $C_6H_{12}O_6$.
(B) H_2O at the end.
(C) light above $\xrightarrow[\text{chlorophyll}]{}$
(D) + $6H_2O$ at the end.

22. C has 4 bonds, H has one bond, O has 2 bonds. Which of the following molecules could NOT be formed from the 3 elements?

(A)

$H-\overset{H}{\underset{H}{C}}--\overset{H}{\underset{H}{C}}--\overset{H}{\underset{H}{C}}-O-H$

(B)

$H\overset{H}{\underset{H}{C}}-O-H$

(C)

$H-\overset{H}{\underset{H}{C}}--\overset{H}{\underset{H}{C}}-\overset{H}{O}-\overset{H}{\underset{H}{C}}-H$

(D)

$H-\overset{H}{\underset{H}{C}}-\overset{H}{C}=\overset{H}{C}-OH$

23. The elements involved in the formation of the molecules above are

(A) Carbon, helium, and oxygen
(B) Calcium, hydrogen, and oxygen
(C) Carbon, hydrogen, and oxygen
(D) Copper, hydrogen, and oxygen

24. A cell is killed with a stain. One difference between this cell and a living cell is

(A) the dead cell does not contain glucose.
(B) the dead cell does not produce energy from glucose.
(C) the living cell contains ADP.
(D) the living cell contains a nucleus.

25. A living cell's "energy" is stored as

(A) glucose
(B) ATP
(C) ADP
(D) mitochondria

26. When the cells "energy" is used, two materials produced are

(A) glucose and starch
(B) ATP and ADP
(C) ADP and phosphate
(D) starch and phosphate

Questions 27-29 refer to the following processes

I Photosynthesis	III Diffusion
II ATP Production	IV Digestion

27. A dog's brain cell would use processes

(A) I and II
(B) II and III only
(C) II, III, and IV
(D) I, II, III, and IV

28. The leaves of a green plant would use processes

(A) I and II only
(B) II and III only
(C) II, III, and IV only
(D) I, II, III, and IV

29. The roots of a green plant would use all of the above processes EXCEPT

(A) I
(B) II
(C) III
(D) IV

30. An experiment in which a peanut and walnut were burned was repeated three times. The results were averaged because

(A) CO_2 was given off.
(B) energy content is the same in all nuts.
(C) the nuts may not have been the same size.
(D) nuts which burn faster contain less energy.

FORM **B**

BIOLOGICAL SCIENCES CURRICULUM STUDY

BSCS Biology, SM Evaluation
1968-69
Cell Energy Processes Unit Test

DIRECTIONS

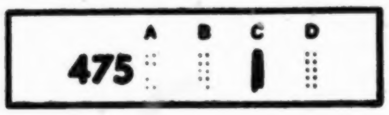
Each question in this test is followed by four choices. Only one of these is the best answer. Read each question and then decide which is the best answer. On the separate answer sheet find the row which has the same number as the question you are answering. In that row blacken the space between the dotted lines under the letter which is the same as the one in front of the answer you choose. Make your marks heavy and black. If you make a mistake, erase completely. If you have to write out an arithmetic problem, use the margin of your answer sheet.

Look at the example below:

475. Heat is a form of

(A) life.
(B) matter.
(C) energy.
(D) work.

Sample of Answer Sheet



Make no marks in this booklet. Do not open this booklet until told to do so.

SPECIAL MATERIALS
CELL ENERGY PROCESSES

Form B

1. Which of the following does NOT describe energy?

   (A) Energy is used to do work.
   (B) Energy can be created and destroyed.
   (C) Energy is trapped for consumers by producers.
   (D) Energy can be transformed from one form to another.

2. Which of the following represents the only necessary energy source(s) for several grasshopper generations?

   (A) Grass
   (B) Sun
   (C) Sun-plants
   (D) plants - 1st order consumers

3. Six people were found unconscious. They were in a tightly closed room. Probably there was

   (A) a decrease of nitrogen in the air.
   (B) an increase of O_2 in the air.
   (C) a decrease of CO_2 in the air
   (D) an increase of CO_2 in the air.

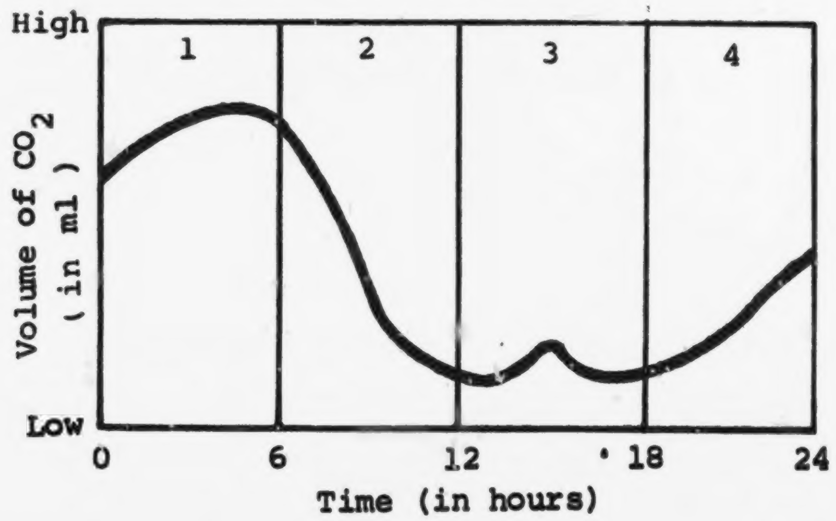
4. When a candle burns, energy is released by the molecules of the candle combining with

   (A) oxygen.
   (B) carbon.
   (C) hydrogen.
   (D) nitrogen.

5. Complete burning of sugar in cells will produce carbon dioxide plus

   (A) water and oxygen
   (B) water + heat and light.
   (C) oxygen + heat.
   (D) water + heat.

Questions 6-8 are based on the following graph showing the volume of CO_2 (carbon dioxide) produced by a white rat over a 24-hour period.



6. During which period was the rat probably using the most glucose?

(A) 1
(B) 2
(C) 3
(D) 4

7. During which period did the rat probably give off the LEAST heat?

(A) 1
(B) 2
(C) 3
(D) 4

8. During which period was the rat probably using the LEAST amount of oxygen?

(A) 1
(B) 2
(C) 3
(D) 4

Questions 9 and 10 are based on the following information:

A simple calorie is the amount of heat needed to raise the temperature of 1 cc of water one degree centigrade. A calorimeter uses heat from a fuel substance to heat a measured quantity of water. In one test, sixteen grams of peanuts were burned in a calorimeter containing 10 grams of water.

substance	Water temperature at beginning	Water temperature at end
peanut	26° C	48.5° C

9. The number of calories per gram of peanut is about

(A) 0.07
(B) 0.14
(C) 14.0
(D) 1.0

10. The total number of calories produced by the peanut sample was

(A) 225
(B) 2250
(C) 140
(D) 1400

The following statements are true or false. Indicate true by blackening the space after A on your answer sheet. Indicate false by blackening the space after letter D.

11. Enzymes are reusable.

12. Enzymes control chemical reactions in living things.

13. Enzymes are not essential to body function.

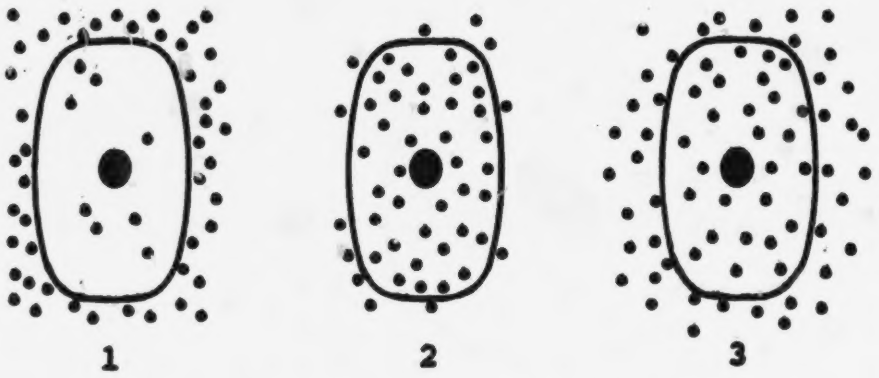
If the condition described below will generally increase enzyme action, blacken the space after the letter A on your answer sheet. If the condition will generally decrease enzyme action, blacken the space after the letter D on your answer sheet.

14. The temperature is raised a few degrees.

15. The amount of substance acted on is increased.

16. The substance acted on is in larger pieces.

Questions 17 and 18 are based on the following information and diagrams of 3 cells. The dots show sugar molecules which cannot pass through the cell membrane.



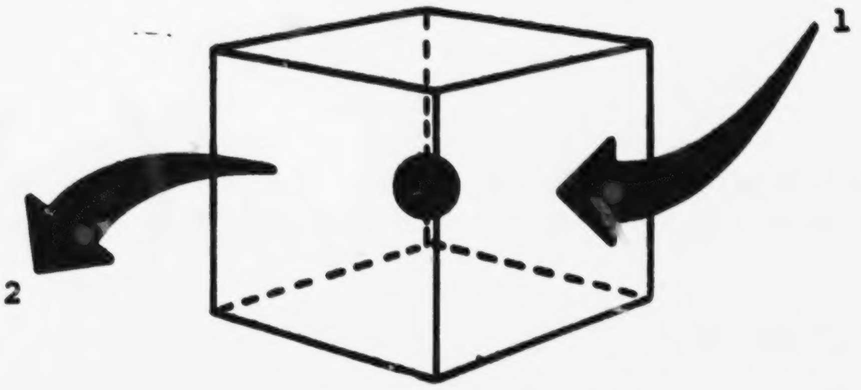
17. In which of the cells will most water molecules diffuse from outside in?

(A) 1 only
(B) 2 only
(C) 1 and 2 only
(D) 1, 2, and 3

18. In which of the cells would there be an approximately equal exchange of water molecules?

(A) 1 only
(B) 2 only
(C) 3 only
(D) 1 and 2

Questions 19 and 20 are based on the following drawing of a living cell. Arrow 1 shows molecules moving in. Arrow 2 shows a different kind of molecule moving out.

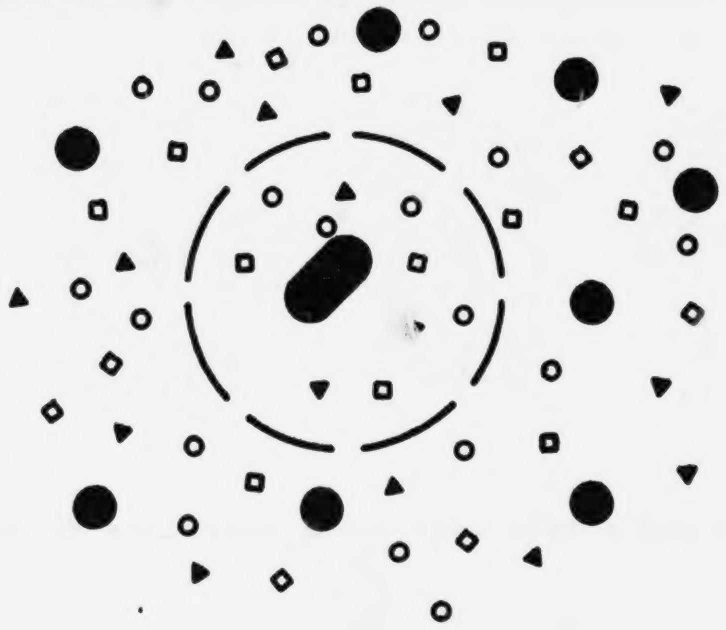


19. What kind of molecule is most likely moving in the direction of Arrow 2?

(A) Glucose
(B) Oxygen
(C) Carbon dioxide
(D) Starch

20. What kind of food molecule is most likely moving in the direction of Arrow 1?

(A) Fat
(B) Glucose
(C) Protein
(D) Starch



21. The particles which can diffuse into the cell are

(A) ○ ▲ □

(B) ▲ □ ●

(C) □ ● ○

(D) ● ○ ▲

22. The kind of particles which will move into the cell at the most rapid rate is

(A) ○

(B) ▲

(C) □

(D) ●

23. The particle which may enter the cell only if something other than pore size is involved is

(A) ○

(B) ▲

(C) □

(D) ●

24. Which of the following statements best describes digestion?

Digestion is the process by which large particles are:

(A) Broken down.
(B) Broken down by enzyme action.
(C) Formed from smaller particles.
(D) Formed from smaller particles by enzyme action.

25. Which of the following equations most accurately represents photosynthesis?

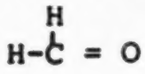
(A) $H_2O + CO_2 \longrightarrow C_6H_{12}O_6 + O_2$

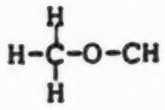
(B) $6H_2O + 6CO_2 \longrightarrow C_6H_{12}O_6 + 6O_2$

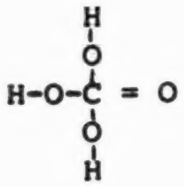
(C) $6H_2O + 6CO_2 \xrightarrow[\text{chlorophyll}]{} \text{glucose}$

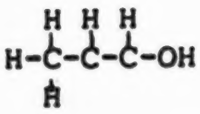
(D) $6H_2O + 6CO_2 \xrightarrow[\text{chlorophyll}]{} C_6H_{12}O_6 + 6O_2$

26. C has 4 bonds, H has 1 bond, O has 2 bonds. Which of the following is a correct formula?

(A) 
$\mathrm{H{-}\overset{\overset{H}{|}}{C}=O}$

(B) 
$\mathrm{H{-}\underset{\underset{H}{|}}{\overset{\overset{H}{|}}{C}}{-}O{-}CH}$

(C) 
$\mathrm{H{-}O{-}\underset{\underset{\underset{H}{|}}{\underset{O}{|}}}{\overset{\overset{\overset{H}{|}}{O}}{\overset{|}{C}}}=O}$

(D) 
$\mathrm{H{-}\underset{\underset{H}{|}}{\overset{\overset{H}{|}}{C}}{-}\overset{\overset{H}{|}}{C}{-}\overset{\overset{H}{|}}{C}{-}OH}$

27. The breakdown of glucose in a cell produces

(A) Energy which is then lost as heat.
(B) Energy which is used by the cell.
(C) Starches which are stored.
(D) Work which produces energy.

. A living cell's energy "generator" is run on energy from

(A) glucose
(B) ATP
(C) ADP
(D) mitochondria

29. The generator of energy in the automobile would be like the cell's

(A) glucose
(B) ATP
(C) ADP
(D) mitochondria

30. When cells use energy which of the following happen?

(A) $\mathrm{ADP} \longrightarrow \mathrm{ATP}$

(B) $\mathrm{ATP} \longrightarrow \mathrm{ADP + P}$

(C) $\mathrm{ADP + P} \longrightarrow \mathrm{ATP}$

(D) $\mathrm{Glucose} \longrightarrow \mathrm{P+P+P}$

FORM A

BIOLOGICAL SCIENCES CURRICULUM STUDY

BSCS Biology, SM Evaluation
1968-69
Genetics Unit Test

DIRECTIONS

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Look at the example below:

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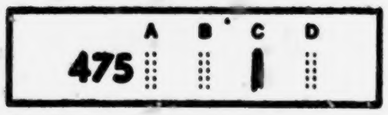
Sample of Answer Sheet



Make no marks in this booklet. Do not open this booklet until told to do so.

SM EVALUATION TEST IV

FORM A

1. Twenty branches cut from the same plant were grown in separate pots. Seven developed flat leaves. Thirteen developed curled leaves. Which of the following is the best explanation for this fact?

   A. The two groups of plants were grown under different conditions.
   B. The two groups of plants have different genes.
   C. The gene for curled leaves is dominant.
   D. The flat leaves resulted from mutations.

2. Several generations of a plant have green leaves with yellow spots. This is probably due to

   A. differences in sunlight.
   B. differences in moisture.
   C. genetic inheritance.
   D. chance.

3. Two brown mice with black ears produced 11 litters of mice, all with black ears. What percent would you expect to be males?

   A. 75%
   B. 33%
   C. 50%
   D. Not enough information to tell

4. Human body cells have 46 chromosomes. Human gametes will have

   A. 92 chromosomes
   B. 46 chromosomes.
   C. 23 chromosomes.
   D. none of the above.

5. If cattle, like humans, have X and Y sex chromosomes, the bull should be represented by

   A. XX
   B. YY
   C. XY
   D. XXYY

6. Genetic inheritance is best defined as

   A. certain characteristics which pass from parent to offspring.
   B. all factors which influence an offspring's characteristics.
   C. the environment in which organisms live.
   D. changes in an organism's characteristics.

Questions 7 and 8 are based on the following information:

A forest ranger has numbered trees from 1 to 100 in a grove of 100 pine trees. A beetle which attacks pine trees is released above the grove.

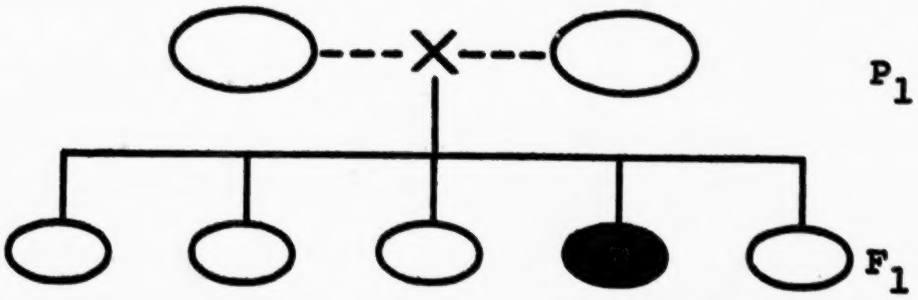
7. What are the chances that the beetle will first attack tree number 76?

   A. 1/50
   B. 1/76
   C. 1/100
   D. 1/760

8. One of the trees is struck by lightening. What are the chances that it is the same tree that was attacked by the beetle?

   A. 1/100
   B. 1/200
   C. 1/7,600
   D. 1/10,000

Questions 9 and 10 refer to the following diagram of a pedigree. The black oval represents a black animal.



9. If W = white and w = black, the parents (P_1) are represented by

   A. Ww x Ww
   B. WW x ww
   C. WW x Ww
   D. Ww x ww

10. The gene makeup of the black animal in the F_1 generation is represented by

   A. WW
   B. Ww
   C. ww
   D. w

---

11. If a fruit fly has normal wings, it must have at least

   A. two genes for normal wings.
   B. one gene for normal wings.
   C. one gene for small wings.
   D. two genes for small wings.

12. The color of a person's eyes is determined by genes from

   A. the mother only.
   B. the father only.
   C. both parents.
   D. either parent, but not both.

13. Which of the following includes all the rest?

    A. Chromosomes
    B. The DNA molecule
    C. Genes
    D. The chemical code

14. Which of the following nucleotide pairs normally exists?

    A. Adenine (A) - Cytocine (C)
    B. Adenine (A) - Guanine (G)
    C. Thymine (T) - Cytosine (C)
    D. Thymine (T) - Adenine (A)

15. A species of bacteria is white when grown in the dark and pink when grown in the light. The color difference is probably due to

    A. the absence of a gene for pink in the white bacteria.
    B. a mutation in the white bacteria.
    C. some factor in the environment.
    D. a recessive gene for white color.

16. If organisms of the same species living in identical environments are different, the difference could be due to

    A. mutations.
    B. different food supplies.
    C. changes in the light.
    D. changes in temperature.

17. A coin is flipped and one of a pair of dice is tossed. What are the chances that a head and a two will show at the same time?

    A. 1/2
    B. 1/6
    C. 1/8
    D. 1/12

18. If the egg and sperm of a species each has 8 chromosomes, the fertilized egg should have

A. 4 chromosomes.
B. 8 chromosomes.
C. 16 chromosomes.
D. 32 chromosomes.

Question 19 refers to the following chart of flower colors.

Number of Parents		Number of Offspring		
Red	White	Red	White	Pink
1	1	7	8	17

19. Which of the following is true?

A. Red is dominant.
B. Red is recessive.
C. White is dominant.
D. Neither white nor red is dominant.

Questions 20 and 21 are concerned with color inheritance in seeds. In the following diagram, black (B) is dominant and white (b) is recessive.

P_1 BB--X--bb

F_1 ?---X---?

F_2 ?

20. The F_1 generation above will be

A. all black.
B. all white.
C. 1/2 black and 1/2 white.
D. 3/4 black and 1/4 white.

21. Crossing the two F_1 plants above will result in F_2 offspring which are

A. all black.
B. all white.
C. 1/2 black and 1/2 white.
D. 3/4 black and 1/4 white.

22. In fruit flies, the gene for small wings (n) is recessive. The gene for normal wings (N) is dominant. If a fruit fly has small wings, it will have

A. two genes for small wings.
B. one gene for small wings.
C. one gene for normal wings.
D. two genes for normal wings.

In the following three individuals, a gene represented by ● is recessive and sex-linked.

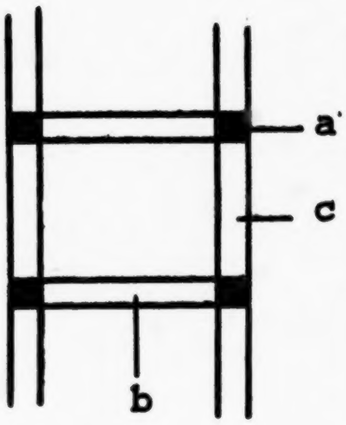
$\overset{\bullet}{X}Y$ $\quad$ $\overset{\bullet}{X}\overset{\bullet}{X}$ $\quad$ $\overset{\bullet}{X}X$
1 2 3

23. The trait controlled by the gene would be visible in

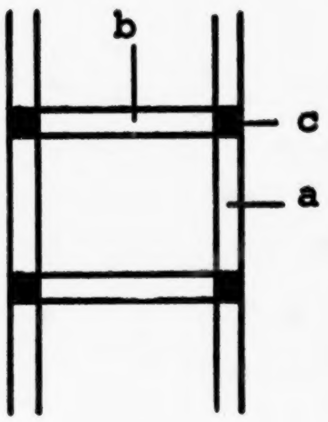
A. 1 only.
B. 1 and 3.
C. 3 only.
D. 1 and 2.

---

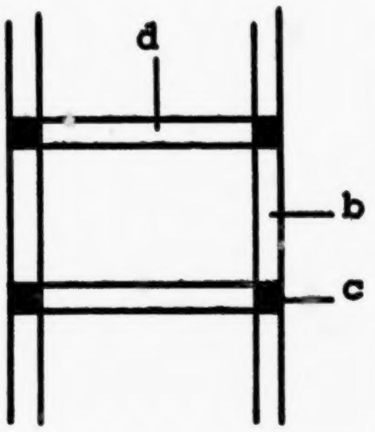
24. If "a" represents sugar
"b" represents phosphates
"c" represents nucleotides
Which of the diagrams below most correctly represents a portion of a DNA molecule?



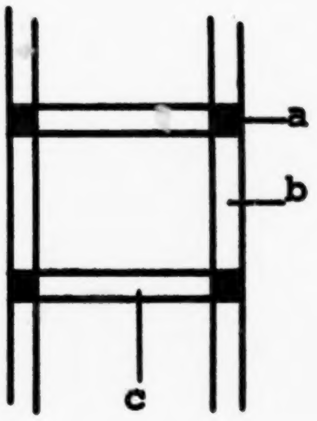
A



B



C



D

25. Sexually reproducing organisms produce gametes by

A. mitosis.
B. meiosis.
C. inheritance.
D. reproduction.

26. Which of the following cell structures is certain to contain genes?

A. ATP molecule
B. Mitochondrion
C. Chromosome
D. Chloroplast

27. Following are four sets of genetic codes in different DNA molecules. Which two of these contain the same genetic information?

I	II	III	IV
A-T	A-T	T-A	T-A
T-A	G-C	A-T	C-G
C-G	A-T	G-C	A-T
C-G	A-T	G-C	G-C

A. I and II
B. I and III
C. II and III
D. II and IV

FORM B

BIOLOGICAL SCIENCES CURRICULUM STUDY

BSCS Biology, SM Evaluation
1968-69
Genetics Unit Test

DIRECTIONS

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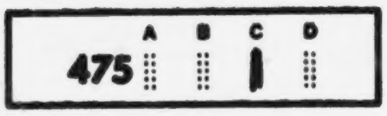


Make no marks in this booklet. Do not open this booklet until told to do so.

SM EVALUATION TEST IV

FORM B

1. If plants with identical genes are different, the difference is probably due to

   A. sex differences.
   B. different parents.
   C. chromosome differences.
   D. different environments.

2. Most navy beans are white and bean-shaped. Suppose one out of every 50 beans is red and one out of 10 is round. What are the chances that a bean will be both red and round?

   A. 1/10
   B. 1/50
   C. 1/60
   D. 1/500

3. 50 identical unlabeled bottles are filled with either sugar or arsenic, a poison which looks like sugar. Forty of the bottles contain sugar. If you choose a bottle and put a spoonful of the contents in your coffee, what are the chances that you will be poisoned?

   A. 1/50
   B. 1/40
   C. 1/5
   D. 1/4

4. Mature gametes have fewer chromosomes than body cells because of

   A. mitosis.
   B. meiosis.
   C. reproduction.
   D. fertilization.

Questions 5 and 6 are based on the following: T is the gene for tall and t is the gene for short. Two individuals mate as follows:

TT -- x -- Tt

5. How many of the offspring will be tall?

   A. All of them
   B. None of them
   C. About 3/4 of them
   D. About 1/4 of them

6. If the F_1 generation breeds freely, how many F_2 offspring will be short?

   A. All of them
   B. About half of them
   C. A few of them
   D. None of them

---

7. A brown-eyed fly has received a gene for brown from

   A. the male parent only.
   B. the female parent only.
   C. both parents.
   D. either parent.

8. A boy has two genes for a certain trait. He could have received

   A. one from his mother.
   B. one from his father.
   C. one from each parent.
   D. both from his grandparents.

9. Which of the following is found in a chromosome?

   A. ATP
   B. DNA
   C. Catalase
   D. Mitochondria

10. The following nucleotide pairs each represent a segment of a different DNA molecule.

I. A-T, T-A, C-G, C-G
II. A-T, G-C, A-T, A-T
III. T-A, A-T, G-C, G-C
IV. T-A, C-G, A-T, G-C

Which of the segments give the same genetic information?

A. I and II
B. I and III
C. II and III
D. II and IV

11. All members of a species of white rabbit on an island off the coast of Alaska develop black ears as they mature. Three young rabbits were taken to Mexico. Their ears did not turn black. Which of the following best explains this fact.

A. Environment influences ear color.
B. Natural selection has occurred.
C. The gene for white ears is recessive.
D. The genes for ear color changed.

Questions 12 and 13 are based on the following information:

Jar A contains 75 black marbles and 25 white marbles. Jar B contains 90 green and 10 red marbles. Without looking, you pick one marble from each jar.

12. What are the chances that the marble removed from Jar A will be black?

A. 1/4
B. 1/3
C. 1/2
D. 3/4

13. How likely is it that you will pick a white and a red marble?

A. 1/35
B. 1/40
C. 1/165
D. 1/250

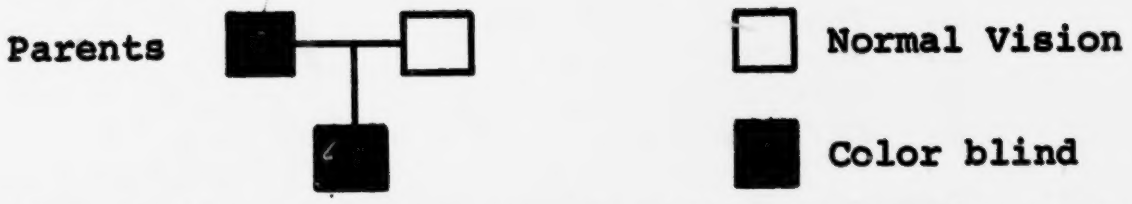
14. If gamete-producing cells have 16 chromosomes, the gametes will have

A. 32 chromosomes
B. 16 chromosomes
C. 8 chromosomes
D. 4 chromosomes

15. A black bull with long horns mates with 25 white cows with long horns. All the calves are black with long horns. These facts prove that

A. long horns are dominant.
B. short horns are dominant.
C. black hair is dominant.
D. black hair is recessive.

Questions 16 and 17 are based on the following pedigree for color blindness:



16. If C is the gene for normal vision and c the gene for color blindness, the parents are

A. CC and cc
B. Cc and Cc
C. cc and cc
D. cc and Cc

17. The gene make-up of the child is

A. Cc
B. cc
C. C
D. c

18. A certain trait is determined by genes on one of the sex chromosomes. If the trait appears in a male, then he has

A. one gene for the trait.
B. two genes for the trait.
C. two X chromosomes.
D. two Y chromosomes.

19. Which of the following nucleotide pairs normally exists?

A. Guanine (G) - Cytocine (C)
B. Guanine (G) - Thymine (T)
C. Adenine (A) - Guanine (G)
D. Cytosine (C) - Adenine (A)

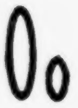
20. Characteristics pass from one generation to the next because of

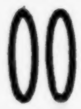
A. genetic inheritance.
B. chance.
C. mutations.
D. environment.

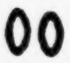
21. Gametes of a species have 16 chromosomes. The fertilized eggs should have

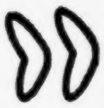
A. 8 chromosomes
B. 16 chromosomes
C. 32 chromosomes
D. 64 chromosomes

22. Which of the following diagrams most likely represents the sex chromosome pair in the human male?


A

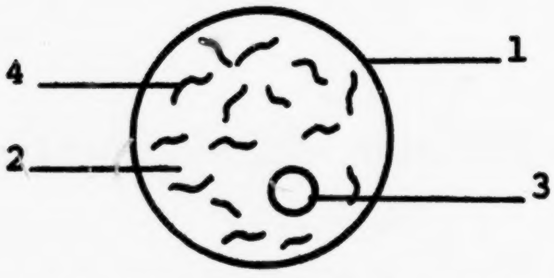

B


C


D

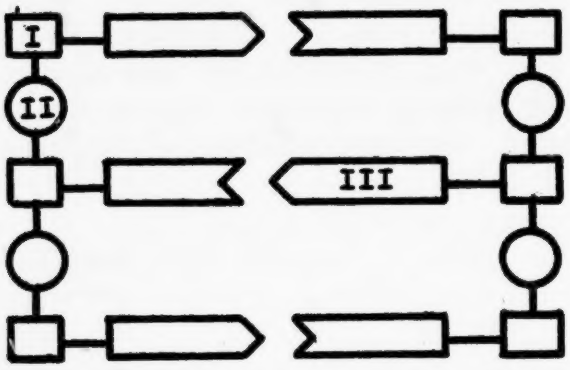
23. A red-eyed fly produces both red and brown-eyed offspring. The red-eyed parent received a gene for red eye color from

A. the male parent only.
B. the female parent only.
C. both parents.
D. either parent.



24. In the cell diagrammed above, genes would ordinarily be located in the part labeled

A. 1
B. 2
C. 3
D. 4



1. Sugar
2. Phosphate
3. Nucleotide

25. To properly label the above diagram of part of a DNA molecule, which combination of word with structure would be correct?

A. I-1, II-2, III-3
B. I-2, II-3, III-1
C. I-3, II-1, III-2
D. I-2, II-1, III-3

---

26. Which of the following best illustrates genetic inheritance?

A. Crossing brown and white mice gives spotted mice.
B. Animals lacking Vitamin D have soft bones.
C. Children of athletes are usually good at sports.
D. Corn grown in a dry climate has small ears.

FORM A

BIOLOGICAL SCIENCES CURRICULUM STUDY

BSCS Biology, SM Evaluation
1968-69
Reproduction and Development Unit Test

DIRECTIONS

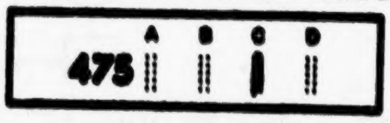
Each question in this test is followed by four choices. Only one of these is the best answer. Read each question and then decide which is the best answer. On the separate answer sheet find the row which has the same number as the question you are answering. In that row blacken the space between the dotted lines under the letter which is the same as the one in front of the answer you choose. Make your marks heavy and black. If you make a mistake, erase completely. If you have to write out an arithmetic problem, use the margin of your answer sheet.

Look at the example below:

475. Heat is a form of

- **(A) life.**
- **(B) matter.**
- **(C) energy.**
- **(D) work.**

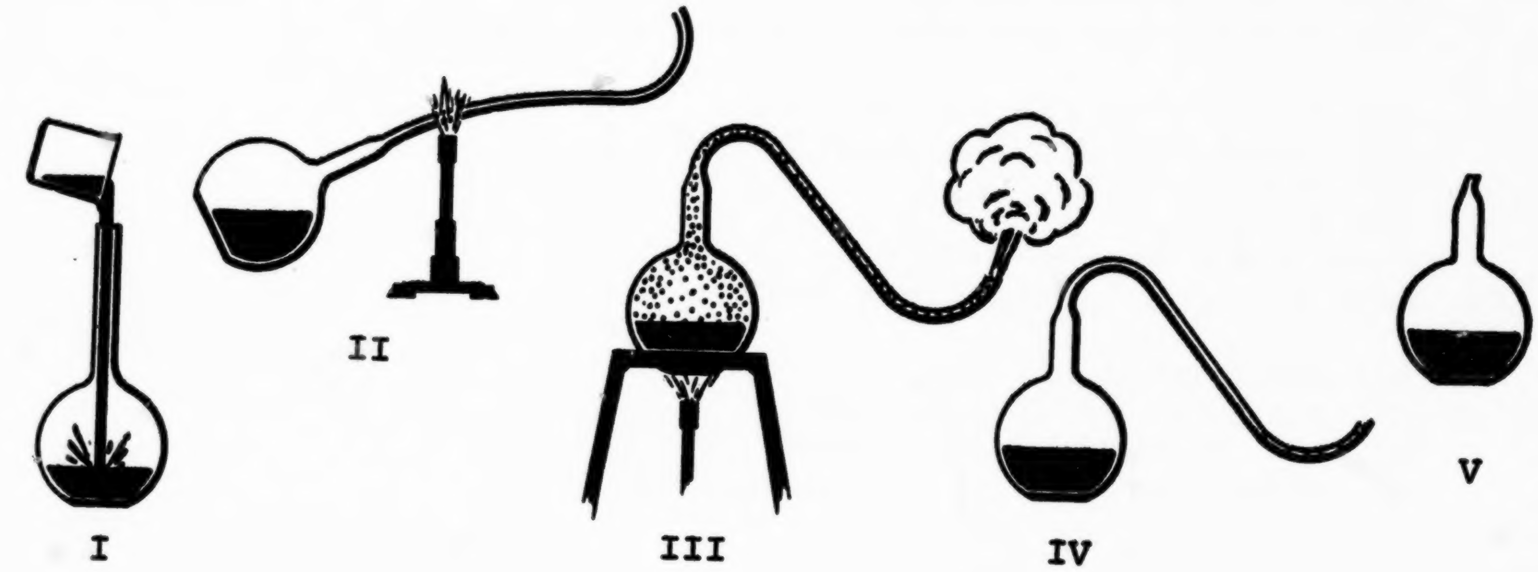
Sample of Answer Sheet



Make no marks in this booklet. Do not open this booklet until told to do so.

SM EVALUATION TEST III

FORM A



Questions 1 through 3 are based on the following description of Pasteur's experiment and on the diagram above.

A mixture of water, brewer's yeast and sugar was placed in a flask (I). Then the neck of the flask was drawn out as shown (II). The liquid was then boiled (III) and allowed to cool. No life appeared in the liquid, even after several months (IV). When the neck of the flask was broken off (V), molds and bacteria appeared within a day or so.

1. The experiment supports the idea that life comes from:

   (A) boiled water
   (B) boiled yeast with sugar
   (C) air
   (D) already existing life

2. The curved neck kept out the:

   (A) organisms
   (B) air
   (C) oxygen
   (D) heat

3. When the neck of the flask was broken, a second experiment began. The control for the second experiment was the:

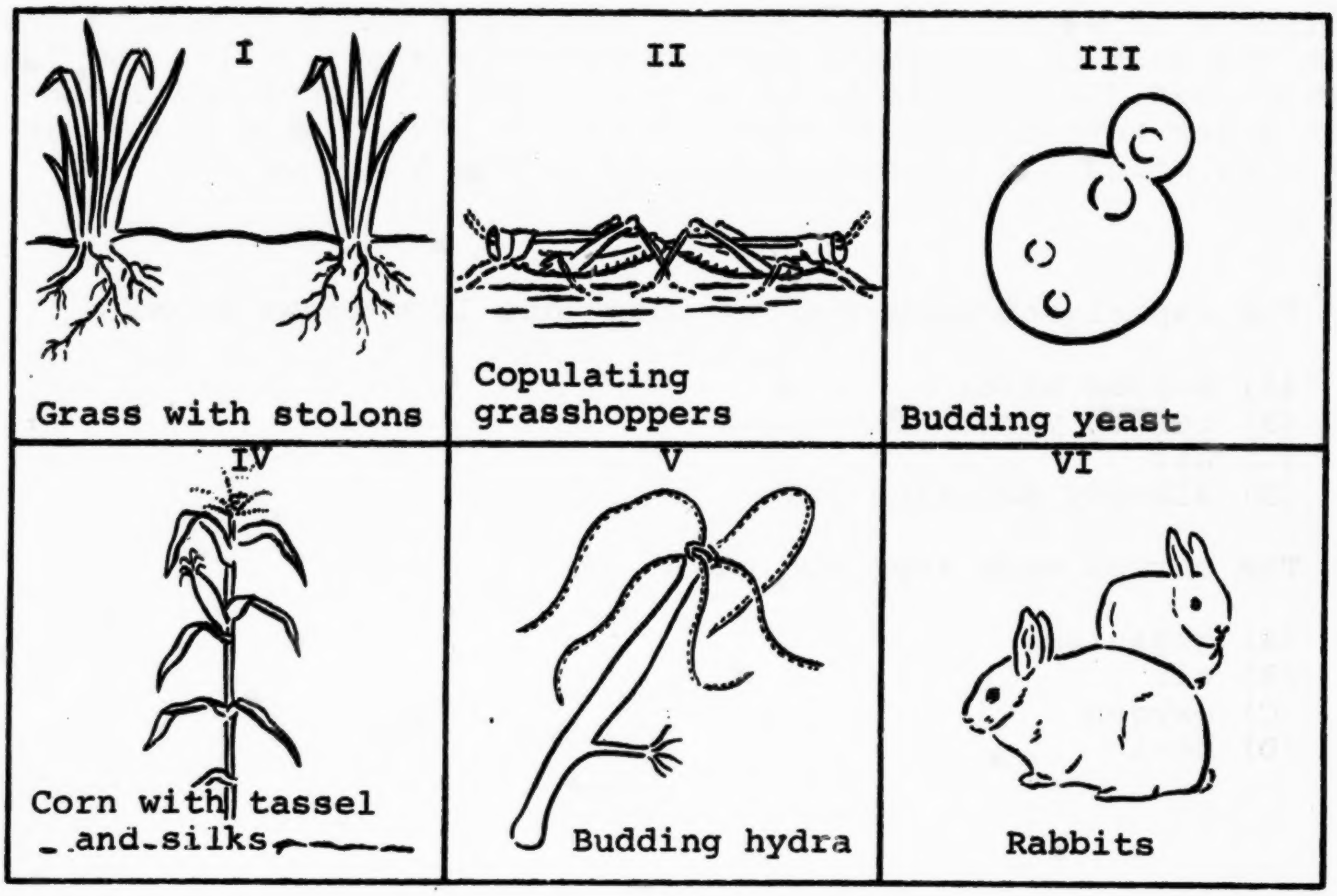
(A) flask with the curved neck
(B) flask without the curved neck
(C) heat
(D) air

---

4. Reproduction is important because it insures:

(A) continuity of life
(B) survival of an individual
(C) new offspring every year
(D) offspring just like the parents

Questions 5 and 6 are based on the following diagram:


I
Grass with stolons
II
Copulating grasshoppers
III
Budding yeast
IV
Corn with tassel and silks
V
Budding hydra
VI
Rabbits

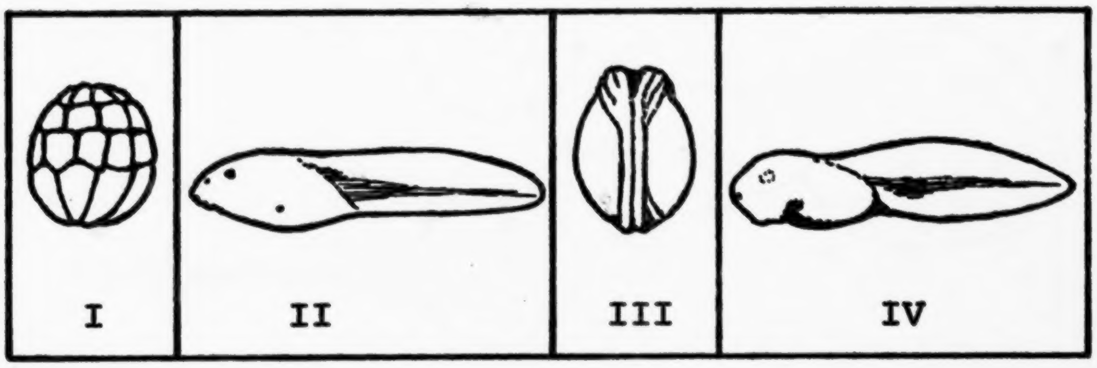
5. In which of the diagrams is asexual reproduction represented?

(A) I, II, and III
(B) I, IV, and VI
(C) III, IV, and V
(D) I, III, and V

6. In which of the diagrams are offspring likely to be most different from the parents?

(A) I, II, and III
(B) I, IV, and VI
(C) II, IV, and VI
(D) I, III, and V

Question 7 is based on the following OUT OF ORDER diagrams of the stages of development of the frog.



7. The earliest and latest stages of frog development shown are:

(A) III and IV
(B) I and IV
(C) II and III
(D) I and II

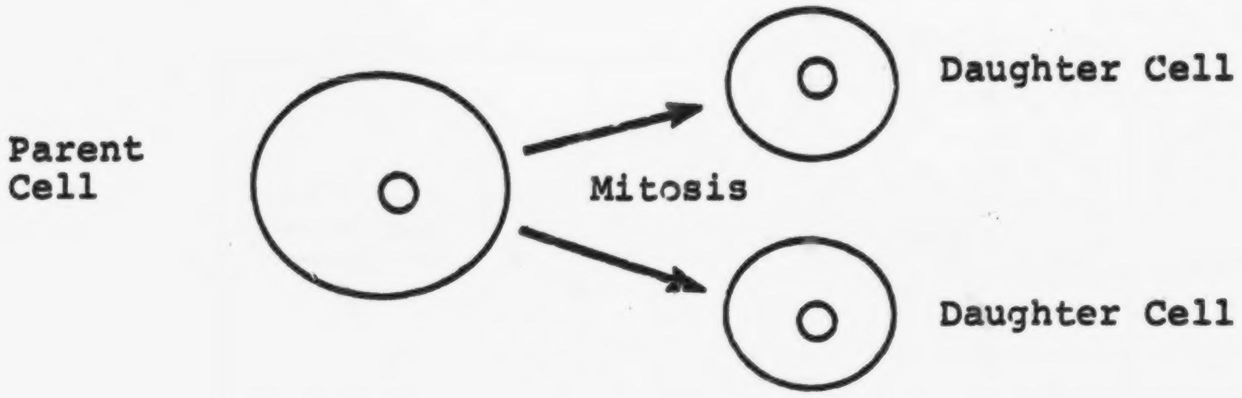
8. The beginning of a new organism occurs when

(A) an egg is laid
(B) cleavage begins
(C) an embryo forms
(D) gametes unite in fertilization

9. Organisms that reproduce asexually almost always produce offspring that are:

(A) different from the parent
(B) identical to the parent
(C) larger than the parent
(D) of a different sex than the parent

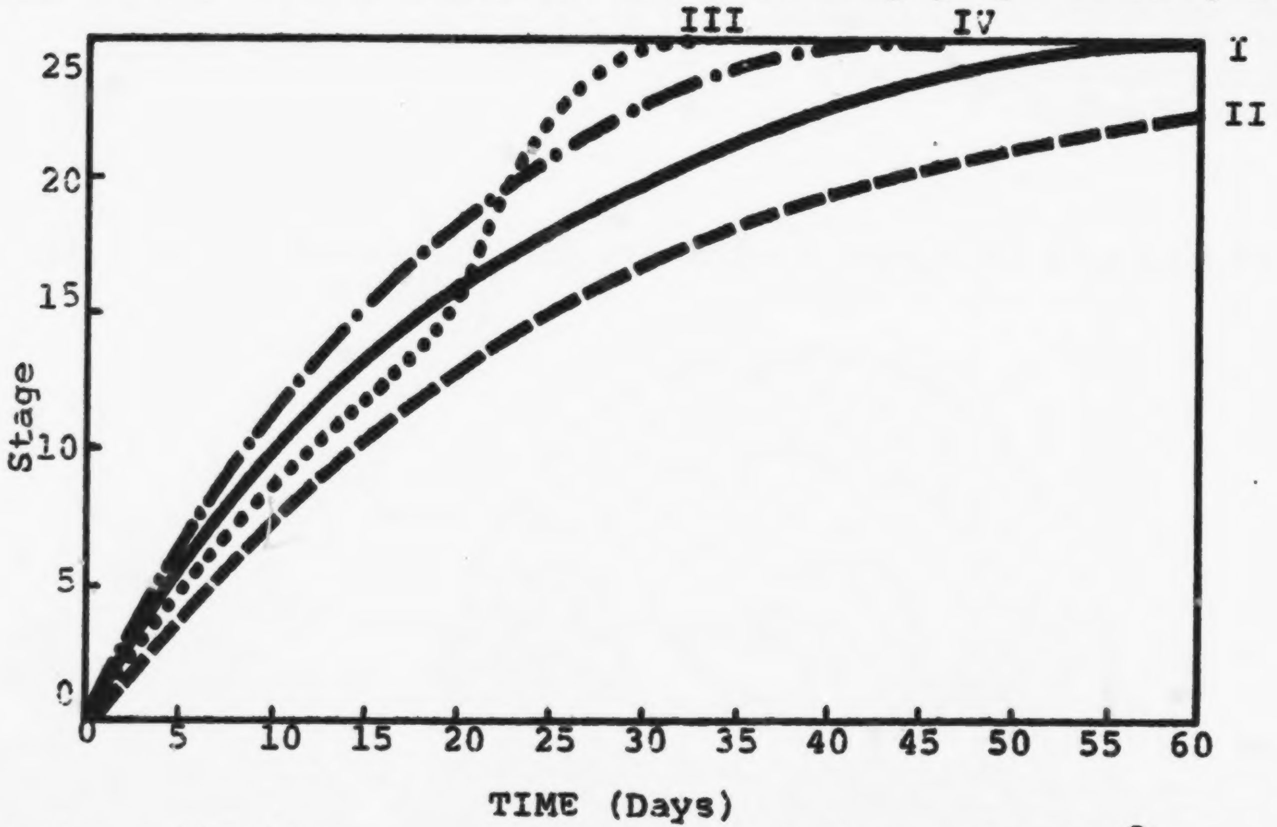
Question 10 is based on the following diagram:



10. The parent cell had 12 chromosomes. Each daughter cell has

(A) 12 chromosomes
(B) 6 chromosomes
(C) 24 chromosomes
(D) 4 chromosomes

Questions 11 and 12 are based on the following graph of frog development:



11. If the solid line represents frog development in 18°C water, then which line represents development at a constantly higher water temperature?

    (A) Line I
    (B) Line II
    (C) Line III
    (D) Line IV

12. Line III probably indicates:

    (A) a slower rate of development than II
    (B) a constantly lower temperature than I
    (C) the death of the embryo
    (D) changing water temperatures

---

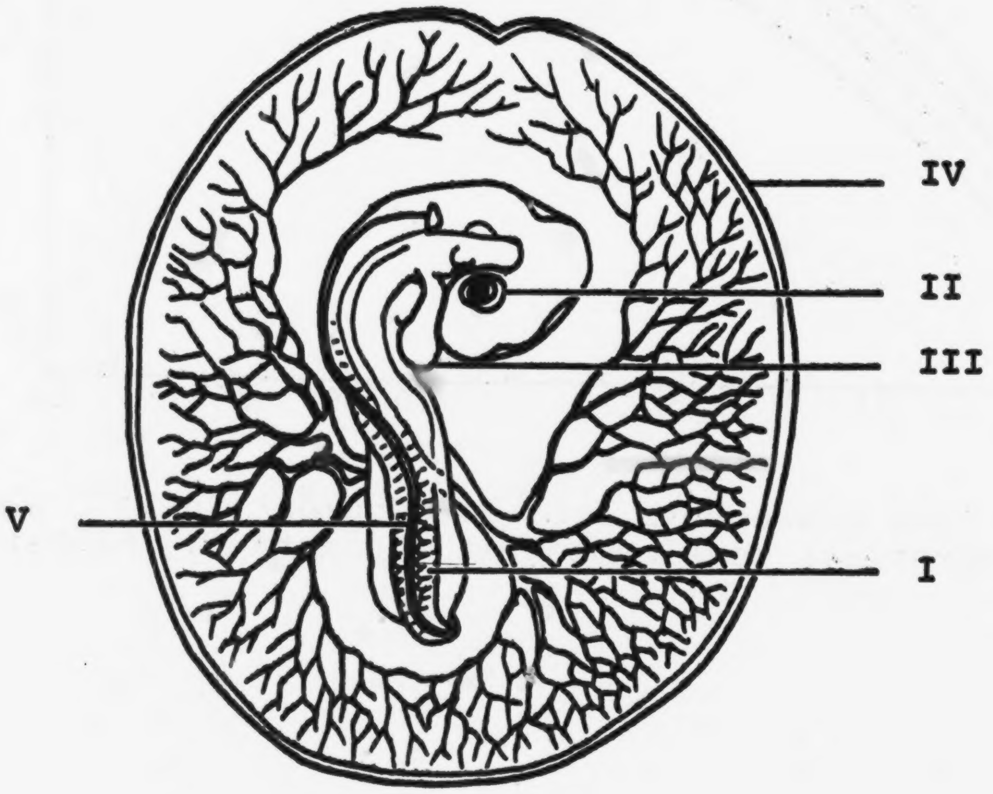
13. All of the following affect the development of the chick embryo EXCEPT:

    (A) carbon dioxide
    (B) relative humidity
    (C) temperature
    (D) nitrogen

14. The process by which a single fertilized egg becomes many different kinds of cells is best called:

- (A) development
- (B) growth
- (C) differentiation
- (D) reproduction

Questions 15 through 18 refer to the following diagram of a 3 day chick embryo.



15. The somites are labeled:

- (A) I
- (B) II
- (C) VI
- (D) V

16. The spinal cord is labeled:

- (A) II
- (B) III
- (C) IV
- (D) V

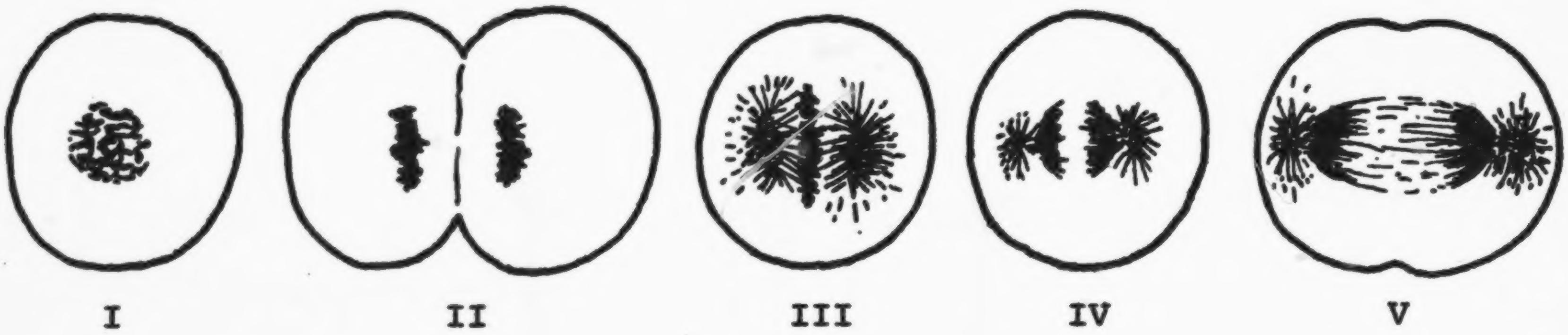
17. The heart is labeled:

(A) I
(B) II
(C) III
(D) IV

18. The yolk sac is labeled:

(A) I
(B) II
(C) III
(D) IV

Question 19 is based on the following diagram:



19. The order in which the cell patterns above would appear during cell division is:

(A) I, III, IV, V, II
(B) I, IV, III, V, II
(C) II, III, IV, V, I
(D) IV, III, V, II, I

---

20. Sexual reproduction usually involves the:

(A) union of sperm with sperm
(B) separation of egg and sperm
(C) union of egg and sperm
(D) union of two eggs

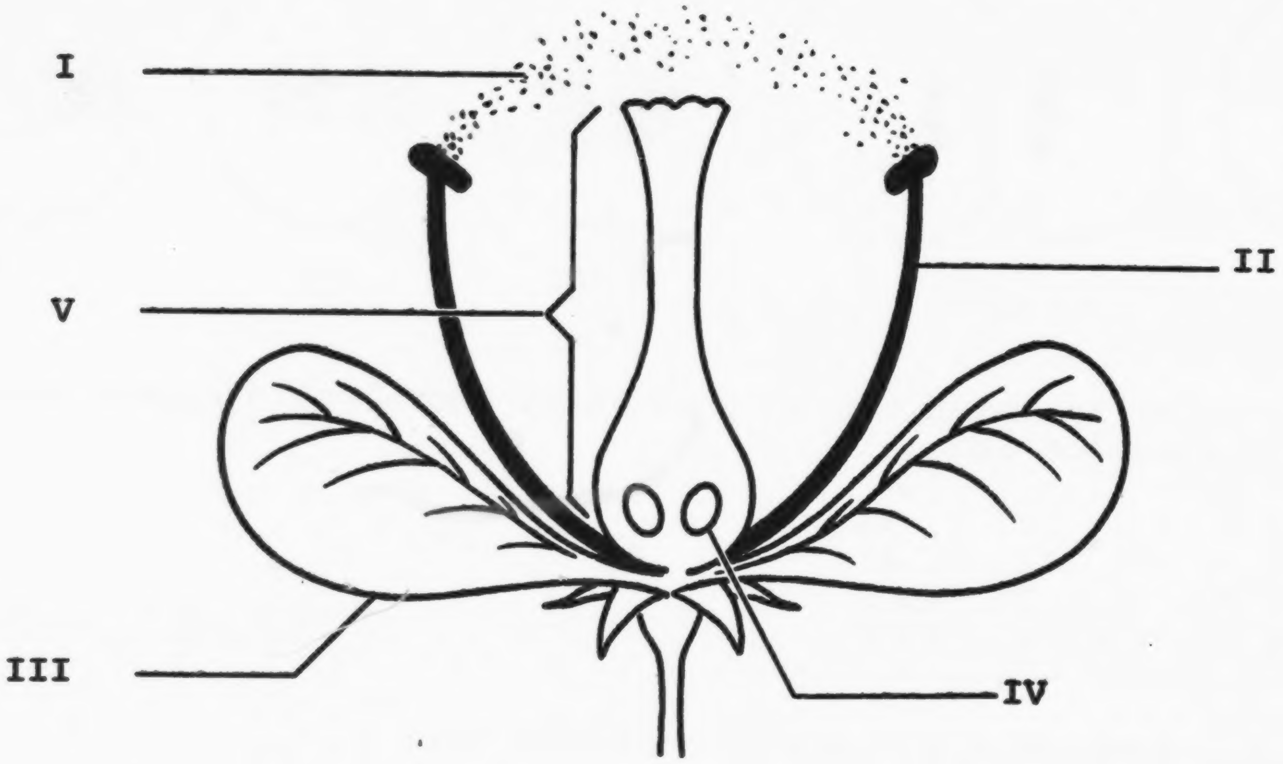
21. Which of the following is the last to appear in the chick embryo?

(A) Limbs
(B) Brain
(C) Feathers
(D) Yolk membrane

22. Which of the following systems can be easily observed in a 3-day chick embryo?

(A) Excretory
(B) Circulatory
(C) Muscular
(D) Nervous

Questions 23 through 25 are based on the following diagram of a flower:



23. Pollen is labeled:

(A) I
(B) II
(C) III
(D) IV

24. The developing seed is labeled:

(A) I
(B) II
(C) III
(D) IV

25. The flower part which functions like the testes of a rat is:

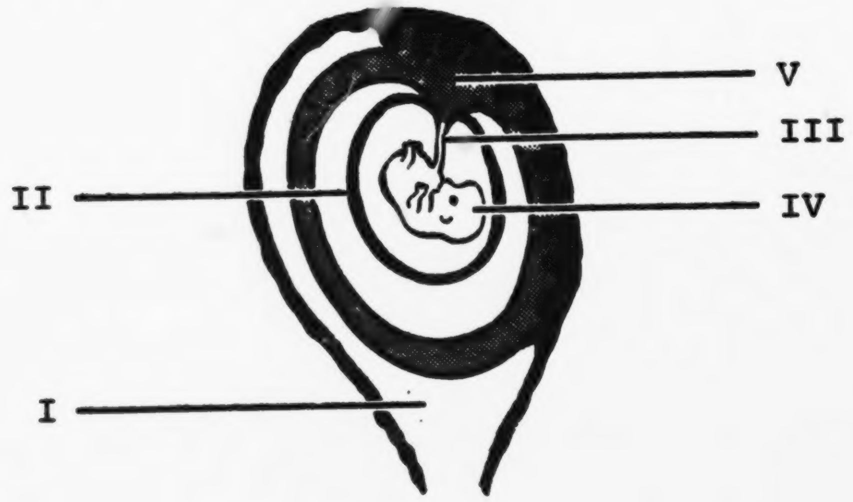
(A) I
(B) II
(C) III
(D) IV

---

26. One hundred tropical bird eggs were incubated under the following conditions: temperature 38°C, humidity 100%, time 100 days. The eggs did NOT hatch. Which of the following is the most likely explanation?

(A) The eggs were too hot
(B) The eggs were NOT fertile
(C) The humidity was too low
(D) No food was available

Questions 27 through 29 are based on the following diagram of a mammalian embryo.



27. I represents the:

(A) Placenta
(B) Uterus
(C) Umbilical cord
(D) Embryo

28. II represents the:

(A) Placenta
(B) Umbilical cord
(C) Amnion
(D) Embryo

29. III represents the:

(A) Umbilical cord
(B) Placenta
(C) Uterus
(D) Amnion

---

30. The breakdown of the uterus lining during menstruation is caused by

(A) reproduction
(B) cleavage
(C) ovulation
(D) hormones

FORM **B**

BIOLOGICAL SCIENCES CURRICULUM STUDY

BSCS Biology, SM Evaluation
1968-69
Reproduction and Development Unit Test

DIRECTIONS

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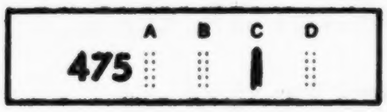
Look at the example below:

475. Heat is a form of

    (A) life.
    (B) matter.
    (C) energy.
    (D) work.

Sample of Answer Sheet

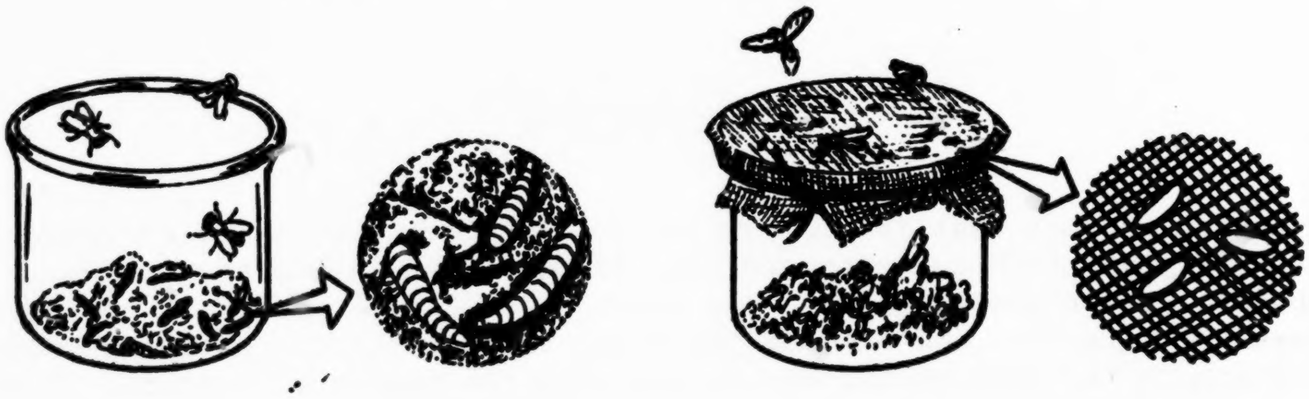


Make no marks in this booklet. Do not open this booklet until told to do so.

SM EVALUATION TEST III

FORM B

Questions 1 and 2 are based on the following diagram of an experiment.



1. If the experiment is to test the hypothesis that worms in decaying meat come from flies' eggs rather than from the decaying meat then the control is the:

   (A) open container
   (B) covered container
   (C) the cloth cover
   (D) decaying meat

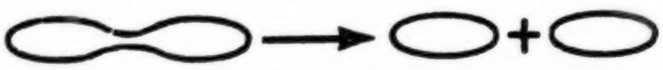
2. The results of this experiment support the hypothesis that:

   (A) life begins by spontaneous generation
   (B) flies begin life by spontaneous generation
   (C) life comes only from life
   (D) eggs are NOT always necessary for life to begin

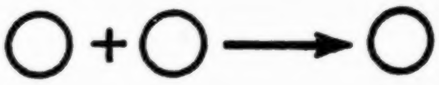
3. New generations of organisms are always the result of:

   (A) mitosis
   (B) respiration
   (C) fertilization
   (D) reproduction

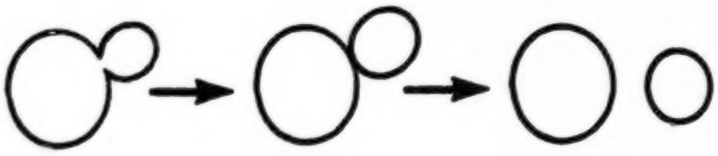
Questions 4 and 5 are based on the following diagrams:



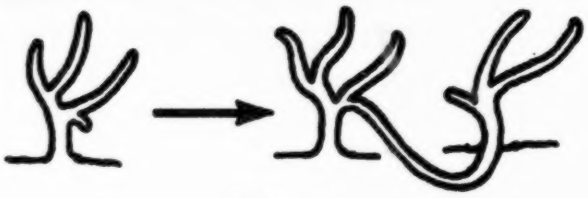
I



III



II



IV

4. Asexual reproduction is represented by:

(A) I, II, and III only
(B) III only
(C) I only
(D) I, II, and IV only

5. Gametes are represented by:

(A) I, II, and III only
(B) I, II, and IV only
(C) I only
(D) III only

6. The process in which several kinds of cells arise from a single reproductive cell is called:

(A) Cell development
(B) Cell differentiation
(C) Tissue formation
(D) Growth

7. If a cell with 6 chromosomes reproduces by mitosis, each of the daughter cells will have:

(A) 6 chromosomes
(B) 3 chromosomes
(C) 12 chromosomes
(D) 2 chromosomes

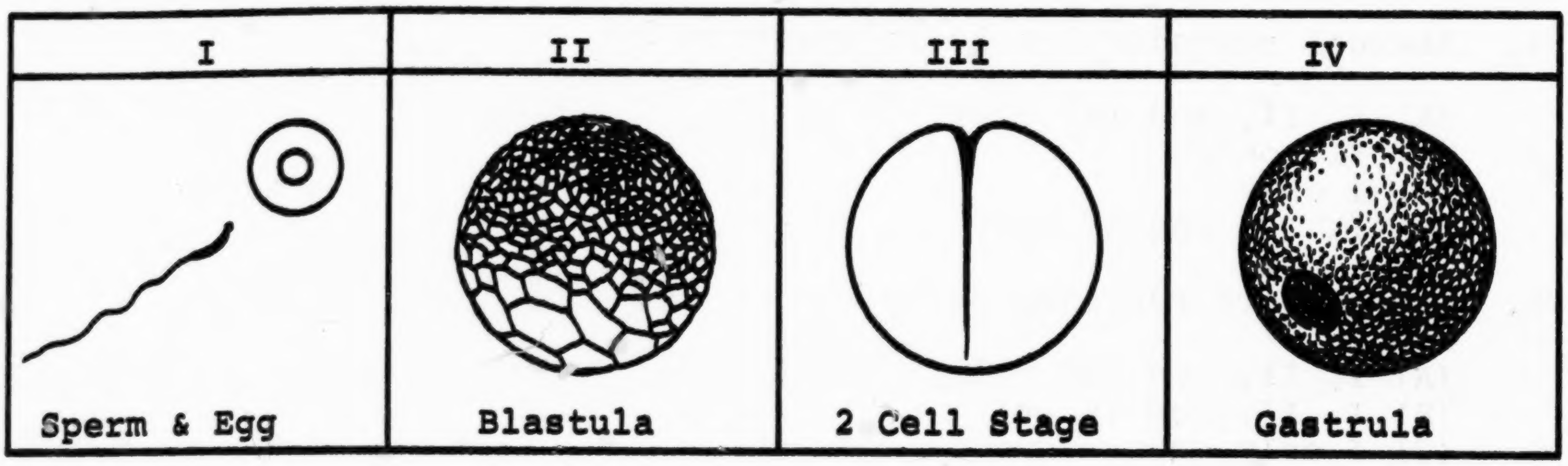
8. The menstrual cycle in humans is controlled by

(A) the moon
(B) ovulation
(C) stored food
(D) pituitary hormones

9. Which of the following list of reproductive events is in the proper order?

(A) Fertilization, ovulation, implantation
(B) Ovulation, fertilization, implantation
(C) Implantation, fertilization, ovulation
(D) Ovulation, implantation, fertilization

Question 10 is based on the following diagram:



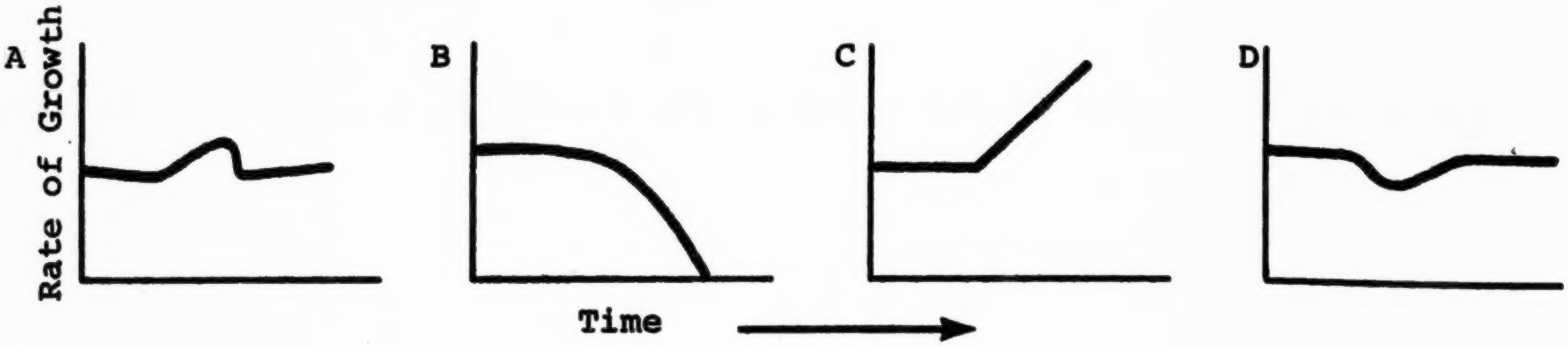
10. The order in which the structures diagramed above occur in frog reproduction and development is:

(A) I, III, IV, II
(B) I, III, II, IV
(C) III, I, II and IV
(D) II, I, IV, III

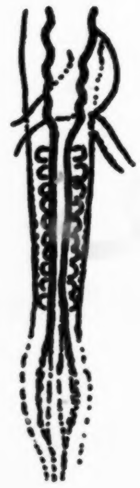
11. Plant I reproduces asexually. Plant II reproduces by seed. The offspring would differ from each other most in:

(A) plant I
(B) plant II
(C) neither; offspring would differ equally in both plants
(D) neither; all offspring would be exactly like the parent plant

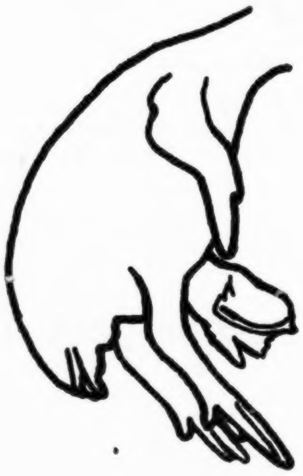
12. Which of the following graphs shows the probable effect of a temporary lowering of water temperature on rate of frog embryo development?



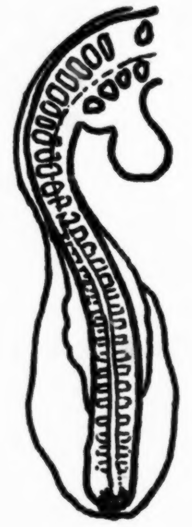
Question 13 is based on the following drawings of portions of chick embryos.



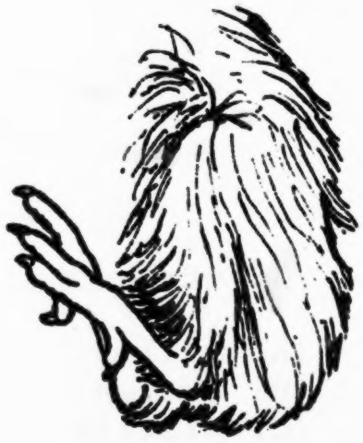
I



II



III



IV

13. Which of the following sequences represents the correct order of development?

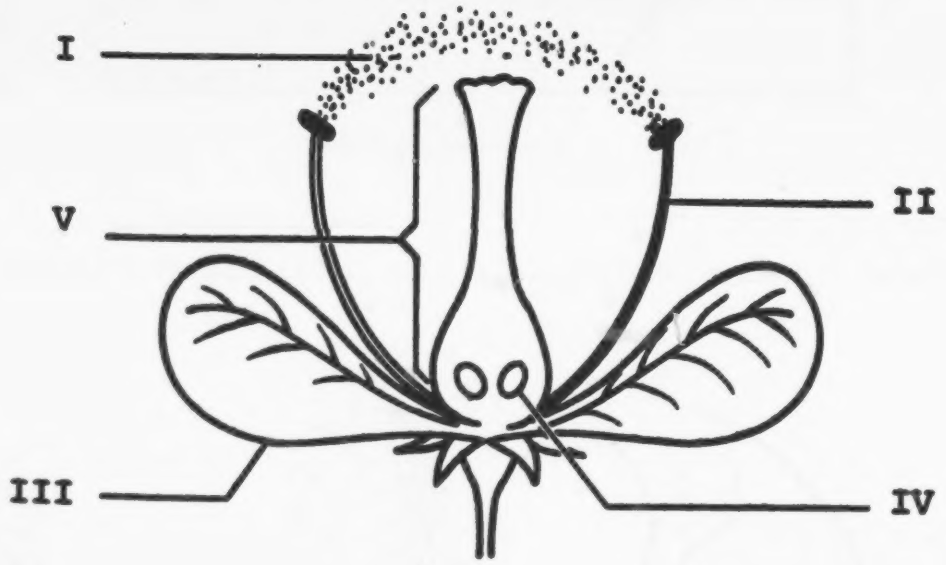
(A) I, II, III, IV
(B) IV, I, II, III
(C) I, III, II, IV
(D) II, I, IV, III

---

14. Asexual reproduction does NOT involve:

(A) Uniting of sperm and egg
(B) Formation of a new individual
(C) Division of one organism into two organisms
(D) Production of more than one new individual

Questions 15 through 17 are based on the following diagram of a flower:



15. The structures contained in the flower part labeled I are called:

(A) pollen
(B) ovules
(C) pistils
(D) ovaries

16. The structure which could be absent from this flower and not affect its function is:

(A) I
(B) II
(C) III
(D) IV

17. The structure which has a function most nearly like the reproductive system of a female mouse is:

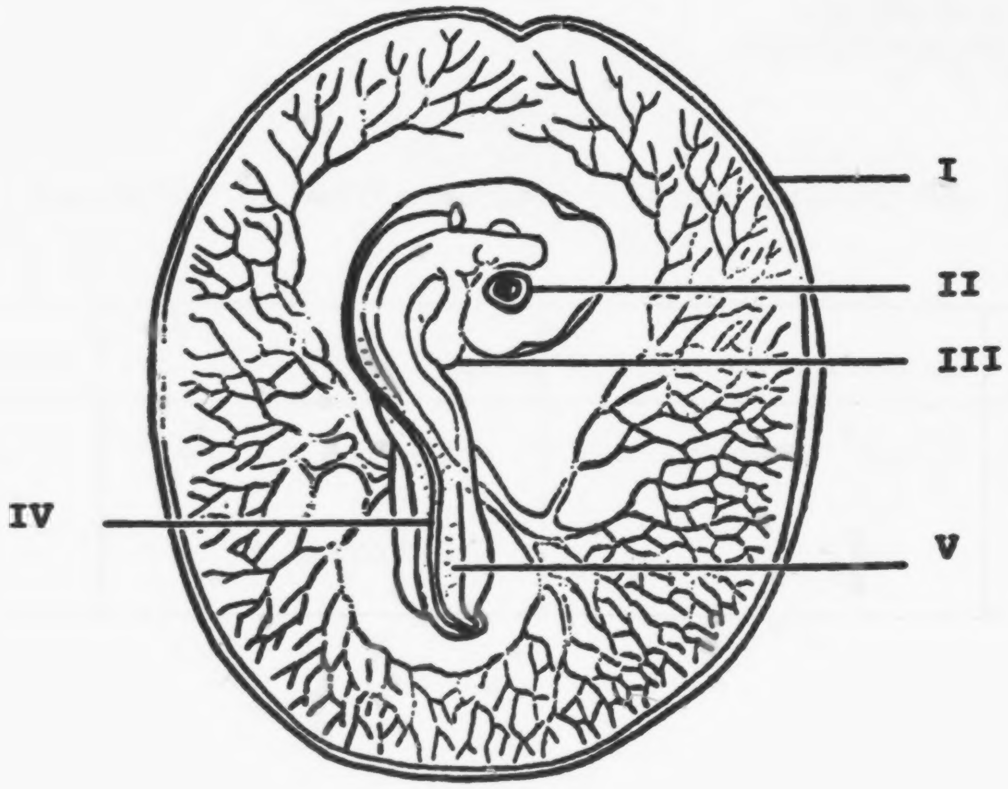
(A) I
(B) II
(C) IV
(D) V

---

18. Sexual reproduction usually involves

(A) pollination
(B) two parents
(C) menstruation
(D) external fertilization

Questions 19 through 21 refer to the following diagram of a 3 day chick embryo.



19. The eyes are labeled:

(A) I
(B) II
(C) III
(D) IV

20. The heart is labeled:

(A) I
(B) II
(C) III
(D) IV

21. The spinal cord is labeled:

(A) I
(B) III
(C) IV
(D) V

---

22. Survival of a population is due to its

(A) growth
(B) cleavage
(C) reproduction
(D) differentiation

Questions 23 and 24 are based on the following information:

Organism	Temperature	Food Supply	Environment
I	20° - 30°C	Internal	Moist Soil or air
II	10°C	External	Salt water

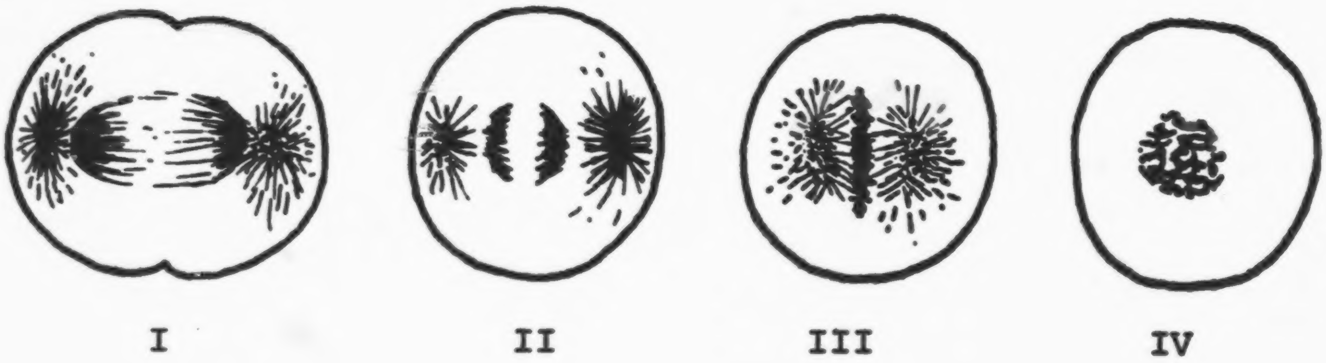
23. Organism I could be a:

- (A) seed
- (B) frog
- (C) chicken
- (D) sea urchin

24. Organism II could be a:

- (A) human
- (B) frog
- (C) chicken
- (D) sea urchin

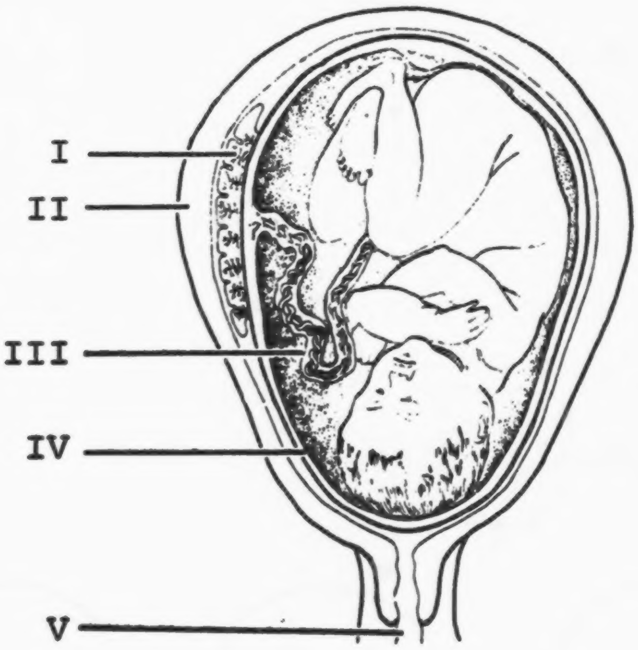
Question 25 is based on the following diagram:



25. If the cells in the diagram were arranged in the order in which they occur during mitosis, the first and last in the sequence would be:

- (A) I and II
- (B) III and I
- (C) II and III
- (D) IV and I

Questions 26-28 are based on the following diagram:



26. The placenta is labeled:

    (A) I
    (B) II
    (C) III
    (D) V

27. The amnion is labeled:

    (A) I
    (B) II
    (C) III
    (D) IV

28. The umbilical cord is labeled:

    (A) I
    (B) II
    (C) III
    (D) IV

29. Which of the following occurs in plants but not in animals?

(A) Cleavage
(B) Respiration
(C) Pollination
(D) Fertilization

30. The idea that life can arise spontaneously was disproved by:

(A) a new hypothesis
(B) consulting authorities
(C) reading the literature
(D) carefully controlled experiments

FORM A

BIOLOGICAL SCIENCES CURRICULUM STUDY

BSCS Biology, SM Evaluation
1968-69
Evolution Unit Test

DIRECTIONS

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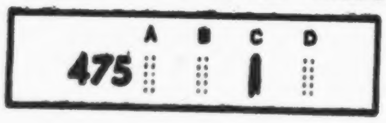
Look at the example below:

475. Heat is a form of

(A) life.
(B) matter.
(C) energy.
(D) work.

Sample of Answer Sheet



Make no marks in this booklet. Do not open this booklet until told to do so.

SM EVALUATION TEST

Evolution

FORM A

1. In which environment would you expect to find a lizard that can change its body color to either green or brown?

   A. A sand desert
   B. A woodland
   C. A snow field
   D. A lake

Questions 2 and 3 are based on the following information.

Genes B and b exist in a population of organisms living in a shaded environment. 10% of the organisms possess gene b. Organisms with two b genes cannot survive in direct sunlight.

2. If the environment remains the same, the percent of b genes in the population will

   A. increase.
   B. decrease.
   C. remain the same.
   D. not be predictable.

3. If the organisms are exposed to more direct sunlight over a period of time, the percent of B and b genes would change in which of the following ways?

   A. B would increase, b would decrease.
   B. B and b would increase.
   C. B would decrease, b would increase.
   D. B and b would decrease.

---

4. Seeds of trees misshapened by the wind are planted in a sheltered area. The young trees can be expected to

   A. grow straighter than their parents.
   B. be shaped like their parents.
   C. die at an early age.
   D. have different genes than their parents.

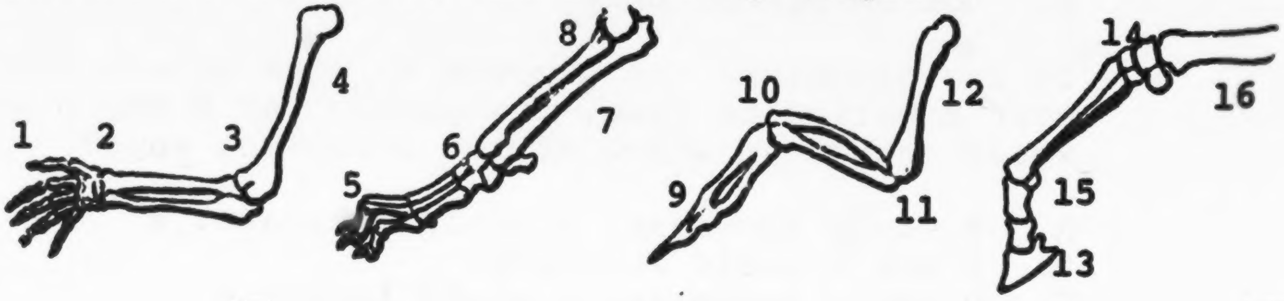
Question 5 refers to the following information.

Fossil	
I	Hard shelled egg
II	Leathery shelled egg
III	Seed
IV	Pollen

5. Listed above are fossils of reproductive structures. Which of these are most closely related?

   A. I and II
   B. II and III
   C. I and IV
   D. III and IV

Question 6 refers to the following diagram:



6. Look at the four pictured skeletons. Which numbers represent the wrist of the animal?

   A. 1, 5, 12, 13
   B. 2, 6, 10, 14
   C. 3, 7, 11, 15
   D. 4, 8, 12, 16

Questions 7 and 8 are based on the following information.

In the country, most nighthawks lay spotted eggs in gravel where they are difficult to see. In the city, they nest on the gravel roofs of large buildings. Records indicate that the number of nighthawks has increased since 1900.

7. Which of the following best accounts for this population change?

   A. More flat roofs covered with gravel.
   B. Fewer natural gravel areas.
   C. More shopping center parking lots.
   D. More homes in the suburbs.

8. Some nighthawks lay plain tan eggs with no spots. These nighthawks might become more numerous where there are

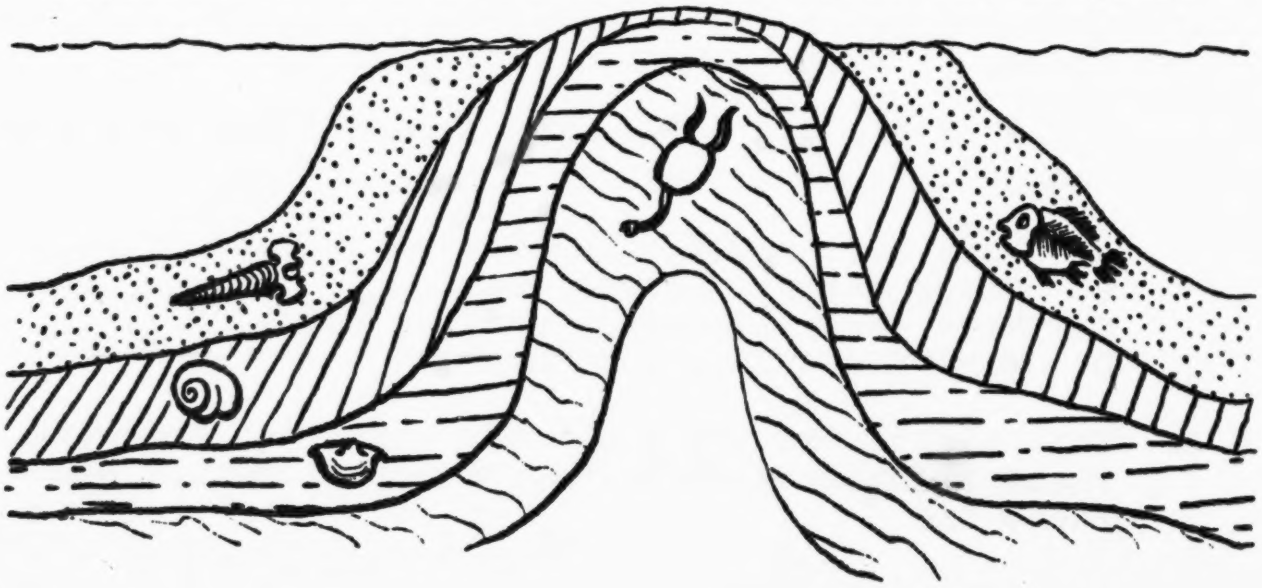
   A. sandy beaches.
   B. gravel roofs.
   C. green lawns.
   D. corn fields.

---

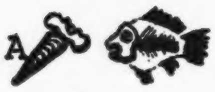
9. On one island, 50% of a population of beetles has large jaws while 50% have much smaller jaws. On another island, 90% of the beetles of that species have large jaws. Of the following, the best explanation of these facts is that

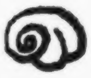
   A. the gene for large jaws is recessive.
   B. the gene for large jaws is dominant.
   C. the gene for large jaws has mutated.
   D. the food supplies on the two islands differ.

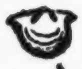
Questions 10 and 11 refer to the following diagram:

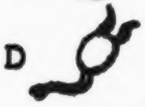


10. The oldest fossils in the above diagram are:

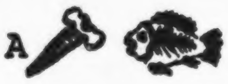
A 

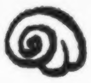
B 

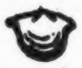
C 

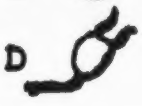
D 

11. The animal/s that died longest ago are

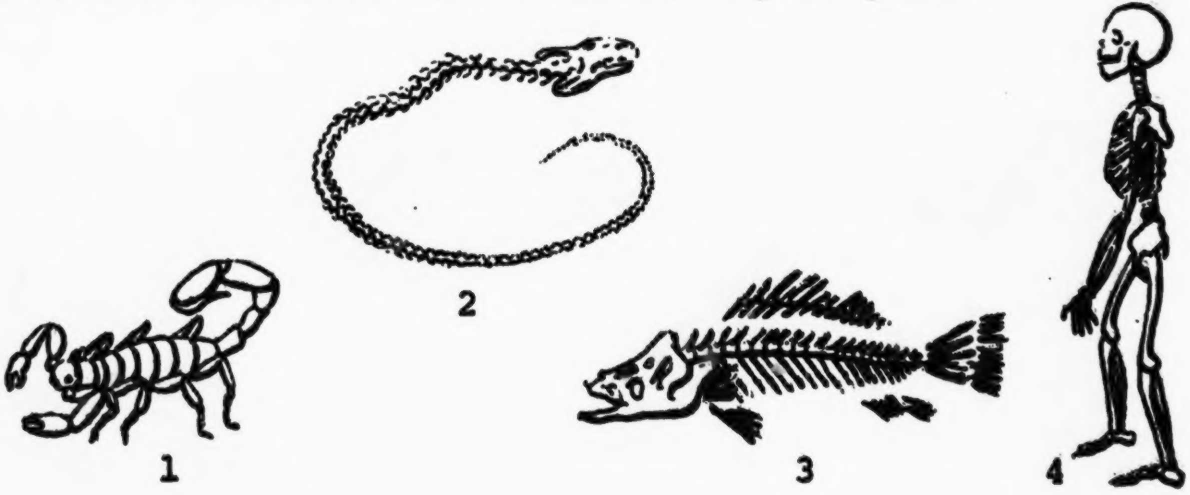
A 

B 

C 

D 

Question 12 refers to the following diagram:



12. Examine the above fossils. Which is least related to the others?

A. 1
B. 2
C. 3
D. 4

---

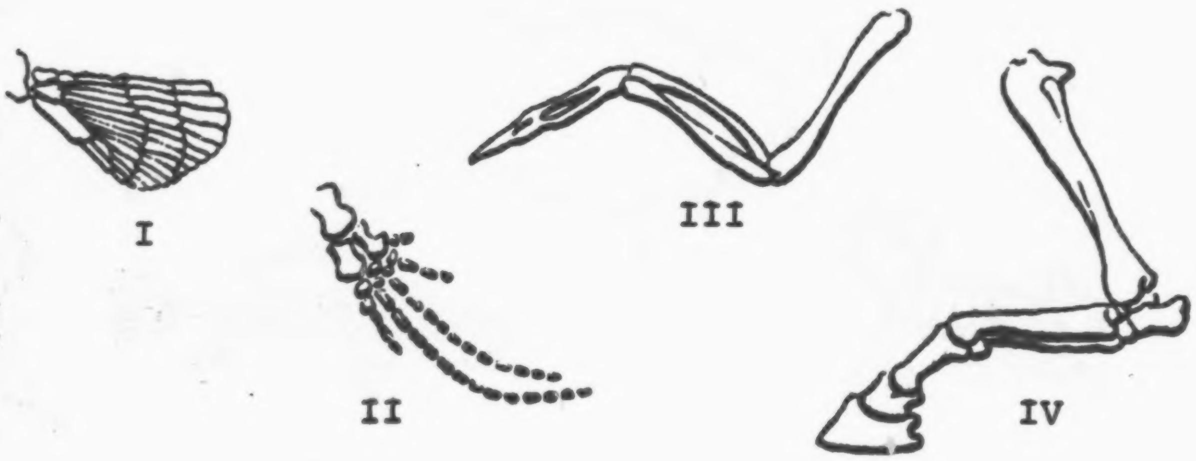
13. One breed of dogs used by the police in some large cities have their tails cropped (cut short). It is reasonable to predict that

A. the environment of the dogs will change.
B. puppies of these dogs will be born with short tails.
C. puppies of these dogs will continue to be born with long tails.
D. the genes of the dogs will change.

14. Other things being equal, the older a fossil is

A. the larger it will be.
B. the smaller it will be.
C. the more layers of rock above it.
D. the fewer layers of rock above it.

Question 15 refers to the following diagram:



15. Which of the above have the same basic structure and function?

A. I and II
B. II and III
C. III and IV
D. I, II and III

---

16. A swarm of green and brown grasshoppers attacked a field of green corn. A flock of birds attacked the grasshoppers. Which of the following helps the grasshoppers most?

A. Birds fly faster than grasshoppers.
B. The green color of corn.
C. The brown color of the grasshoppers.
D. The small size of the grasshoppers.

FORM B

BIOLOGICAL SCIENCES CURRICULUM STUDY

BSCS Biology, SM Evaluation
1968-69
Evolution Unit Test

DIRECTIONS

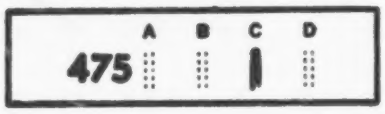
Each question in this test is followed by four choices. Only one of these is the best answer. Read each question and then decide which is the best answer. On the separate answer sheet find the row which has the same number as the question you are answering. In that row blacken the space between the dotted lines under the letter which is the same as the one in front of the answer you choose. Make your marks heavy and black. If you make a mistake, erase completely. If you have to write out an arithmetic problem, use the margin of your answer sheet.

Look at the example below:

475. Heat is a form of

(A) life.
(B) matter.
(C) energy.
(D) work.

Sample of Answer Sheet



Make no marks in this booklet. Do not open this booklet until told to do so.

SM EVALUATION TEST

Evolution

FORM B

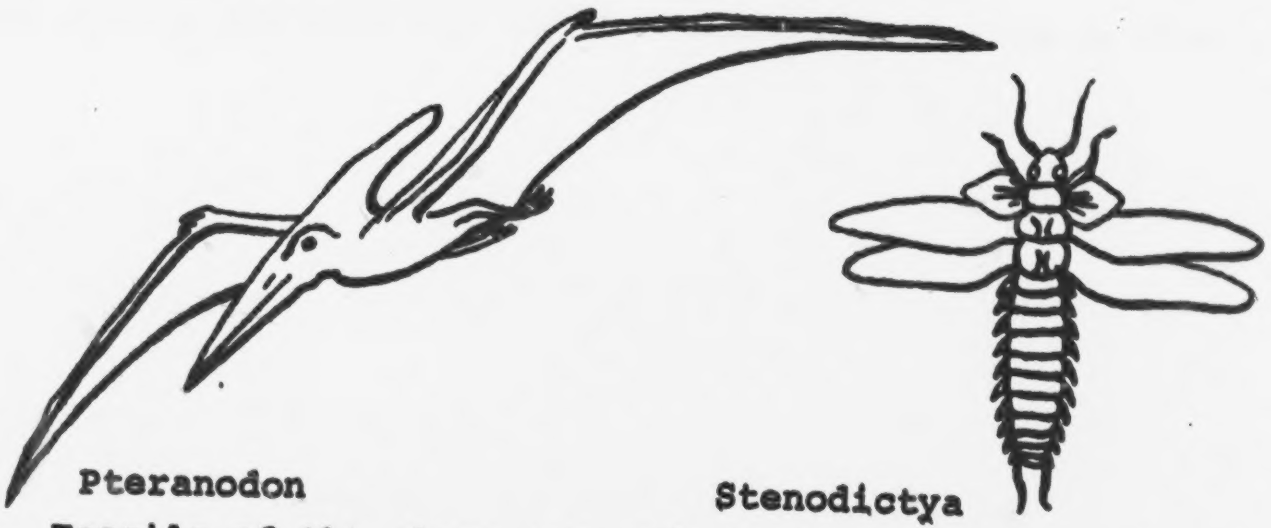
A population of bees use their tongues to get food from only two kinds of clover. The food is located near the bottom of a narrow flower tube. Flower tube length varies from 4 to 6 mm. Bee tongue length varies from 3 to 6 mm.

1. Which of the following would probably happen if flowers with tubes less than 5 mm were killed by a disease?

   A. All of the bees would starve.
   B. None of the bees would starve.
   C. Short-tongued bees would starve.
   D. Long-tongued bees would starve.

2. Which of the following would be true of the bee population in later years?

   A. It will disappear entirely.
   B. It will be much smaller.
   C. The average tongue will be longer.
   D. The average tongue will be shorter.



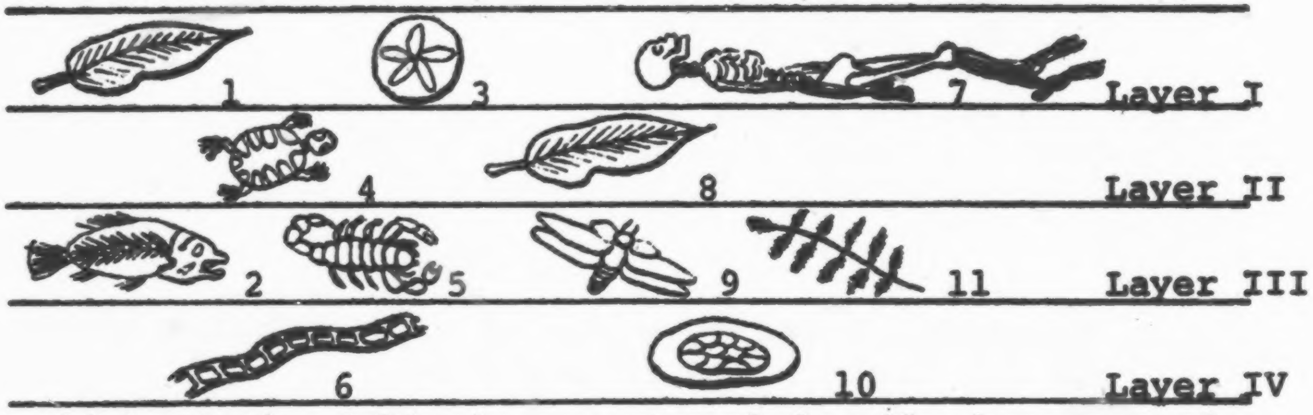
3. Fossils of the above two animals have been found. In order for you to decide if they were closely related you should

   A. look at their skeletons.
   B. look at their wings.
   C. look at their sizes.
   D. look at their ages.

4. A man accidentally cuts off his little finger. If his wife has the same accident, their children will be born

A. without part of a little finger.
B. with complete little fingers.
C. without a gene for complete little fingers.
D. with two genes for no little fingers.

Questions 5, 6, and 7 refer to the following diagram:



5. Which of the following groups of fossils is arranged from oldest to youngest?

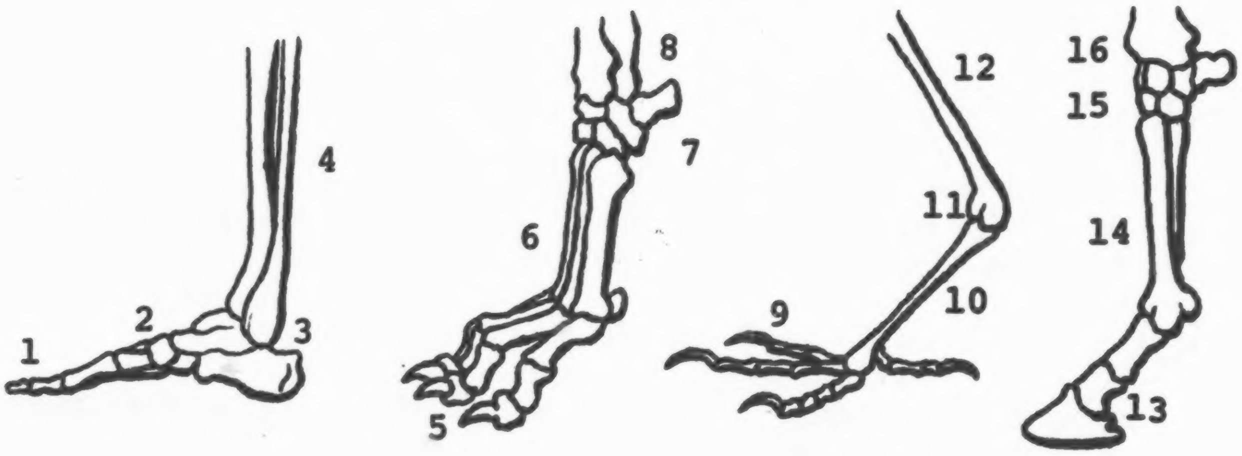
A. 10, 4, 3, 5
B. 6, 9, 4, 7
C. 2, 4, 8, 3
D. 1, 8, 5, 10

6. What do fossils 1, 3 and 7 have in common?

A. They lived at about the same time.
B. Their skeletons are alike.
C. They first appeared at the same time.
D. They all appeared in layer II.

7. If layer III is 250 million years old then

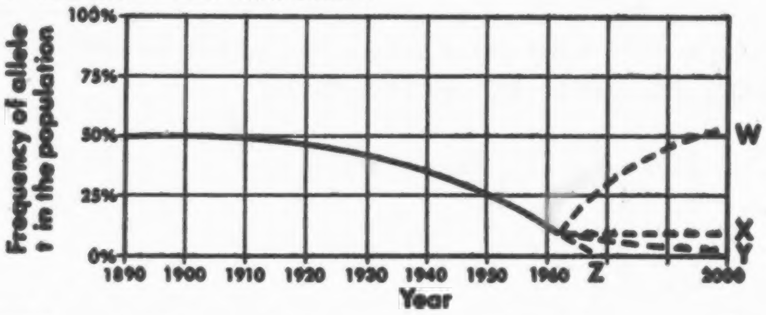
A. organism 7 is about 250 million years old.
B. organism 2 is about 250 million years old.
C. organism 7 is older than 250 million years.
D. organism 2 is about 100 million years old.



8. Look at the four pictured skeletons. Which numbers represent the foot (excluding toes) of the animal?

A. 1, 5, 9, 13
B. 2, 6, 9, 13
C. 2, 7, 10, 14
D. 2, 6, 10, 14

Questions 9 and 10 refer to the following graph. Allele t is for light color in moths.



9. About 1920, industrial pollution began darkening the environment. The decrease in allele t in the moth population since 1920 most likely is due to

A. mutation.
B. migration.
D. selection.
D. non-random mating.

10. In 1960 the industrial pollution stopped. If the air remained clean until the year 2000, the frequency of allele t would most likely resemble

A. W.
B. X.
C. Y.

D. Z

Questions 11 and 12 are based on the following information:

Over the past 100 years, 90 percent of the leopards in Central India have had spotted fur while 10% have had all black fur.

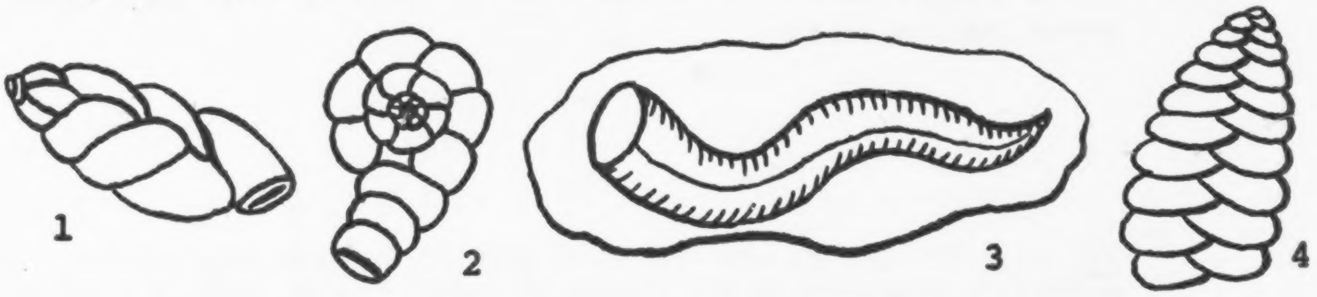
11. Assuming that all other conditions remain the same, what percent of the leopards will have black fur 50 years from now?

    A. More than 30%.
    B. About 20%.
    C. About 10%.
    D. Close to 0%.

12. Assume that coats made from spotted leopard skins become very popular. What percent of the leopards would you expect to have black fur 50 years from now?

    A. 100%.
    B. More than 20%.
    C. About 10%.
    D. Close to 0%.

Question 13 refers to the following diagram:



13. Which three fossils are most closely related?

    A. 1, 2, 3
    B. 2, 3, 4
    C. 1, 3, 4
    D. 1, 2, 4

Two populations of brown deer inhabit an area of tall brown grass. One population averages 4 feet in height, the other averages two feet in height. Fewer tall deer than short ones survive the hunting season.

14. Which environmental factor most influences the kind of deer killed?

    A. Deer height
    B. Hunter choice
    C. Grass height
    D. Grass color

Two populations of lizards are able to change their color to green or brown in the following amounts of time:

	Brown to Green	Green to Brown
Pop. 1	45 sec.	120 sec.
Pop. 2	150 sec.	65 sec.

In a certain area, Pop. 1 is found in large numbers and Pop. 2 is quite rare.

15. Which is most likely true of the environment?

    A. A mostly green background.
    B. A mostly brown background.
    C. Equal amounts of green and brown background.
    D. All brown with no green.

---

16. In a population of 1000 fruit flies, the percentages of gene pairs were

    TT = 19%
    Tt = 57%
    tt - 38%

    If the fruit flies were free to breed normally, and if nothing happened to disturb the "gene pool", then the percentage of tt two generations later would be nearest to

    A. 19%.
    B. 38%.
    C. 57%.
    D. 75%.
